

Memo

TO: Josie Tayse, Final Design Project Manager
Metro District, Waters Edge

FROM: Paul Martin, Assistant Foundations Engineer
Geotechnical Engineering Section

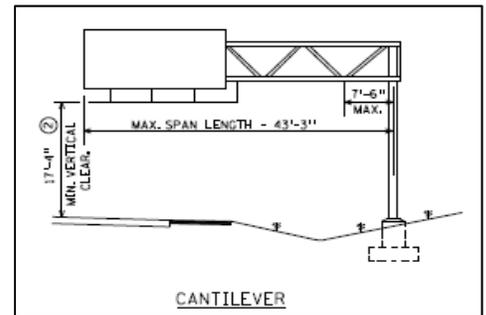
Concur: Rich Lamb, Foundations Design Build Engineer
Geotechnical Engineering Section

DATE: December 15, 2017

SUBJECT: SP 8825-652, Metrowide Overhead Sign Structure Replacement
Subsurface Evaluation and Foundation Recommendation Report

1.0 Project Summary

This report is provided in response to a request by the Metro District to provide a subsurface investigation and foundation recommendations for eight proposed new overhead sign structures being constructed along TH 7, TH 36, TH 47, TH 94 (two sites), TH 100 (two sites) and TH 280. The sign structure types will include both Sign Bridge and Cantilever. Each sign structure will be supported by either spread footings or drilled shaft foundations.



2.0 Subsurface Investigation

The soils at the proposed sign locations were investigated using Standard Penetration Test Borings (SPT) or Cone Penetration Test (CPT) Soundings in October, November and December, 2017. The CPT soundings were interpreted for general soil behavior type and estimated water table elevation. No soil samples were taken so the interpreted soil behavior type may not exactly match what soil is present, but should indicate how it behaves if compared to standard soils.

Based on the results of the investigation we determined that the foundation soils at the proposed sign locations vary; they include loose to very dense sands and layered soft to stiff sandy loam, clay and silt soils. Groundwater was detected in some of the borings and CPT soundings and perched water should also be expected in areas where layered soils exist. Please refer to the attached sounding and boring logs for the most complete description of the foundation soils.

Table 1, below, provides general summaries of the soil and groundwater conditions encountered at/near each sign location.



Table 1, Summary of Estimated Soil and Groundwater Conditions

| Boring or Sounding | Location | Indicated Groundwater Depth (feet) | Summary of Interpreted Soils (Depths in feet) | Interpreted N-Value |
|--------------------|--|------------------------------------|--|--------------------------------|
| T01 | Site 1, TH 7 WB STA 311+26, 36' Lt | 6.9 | Sandy Loam and Sand to 9' Clays and Silts to 16.5' Sandy Loam and Clay Loam w/Sand & Gravel | 25-41 12-19 27-39 |
| C02 | Site 7, TH 36 EB Ramp to SB TH 694 | *6.5 | Frozen soils and Sands to 7' Layered Silts, Clays and Sands to about 25' Sandy Loam and Sands to termination | 20-50+ 3-20 14-36 |
| T03 | Site 8, TH 47 SB, STA 523+79, 43' Rt | 8.5 | Fine and very fine grained sands | 12-85 |
| T04 | Site 8, TH 47 SB, STA 523+81, 20' Lt | 11.2 | Fine sand, very fine sand and loamy sand | 3-66 |
| T05 | Site 9, TH 94 WB STA 2118+46, 31 Lt | NI-36' | Plastic Silt Loam to 10' Sands & Gravel to termination. | 15-33 21-48 |
| T06 | Site 10, TH 94 WB, STA 428+52, 52' Lt | * | Loamy sand to 4, clay loam to 6.5, silt loam to 9, sands to 19, sandy clay to 31.5, sandy loam | 23,12 8,7-23 10-13,9-17 |
| T07 | Site 10, TH 94 WB, STA 428+55, 28' Rt | * | Sand fill to 11.5, topsoil to 13, sand to 21.5, clay to 31.5, over sandy loam and silty clay | 18-41, 14 8-21,6-11 6-22 |
| C08a | Site 11, TH 100 SB STA 183+01, 42'Rt | * | Layered Clays, Sands and Silts to 10.5' Refusal on dense Sand | 3-32 50+ |
| C09 | Site 12, TH 100 SB STA 227+10, 32'Lt | * | Sands layered with Silt and Clay to 29.5' Refusal on Dense Sand | 4-50 30-50+ |
| TC-2 (1969) | Site 13, TH 280 NB near STA 88+60 | 25 | Plastic Sandy Loam to 13' Sand & Gravel to termination. | 11-16 20-75 |

*Perched layers may occur NI- Not Indicated to

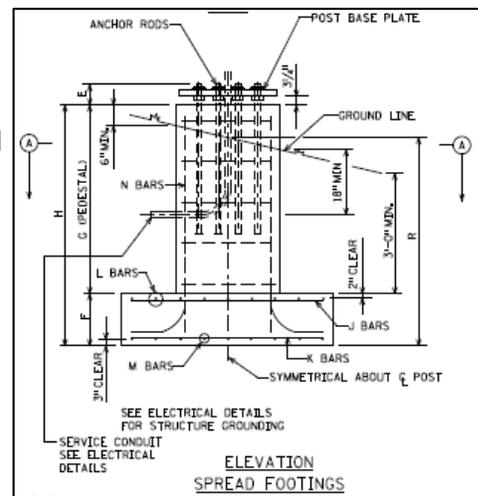
3.0 Foundation analysis

As part of the overhead sign standard drawings (revised 11-21-2014), standard foundations were developed to support overhead signs. These standard foundations consist of two spread footing and two drilled shaft designs to be used on different sign pole sizes (see Drawing ST-3, Standard Overhead Sign Supports Interim Design B).

- Spread Footings: 12 ½ ft. x 18 ft. or 9 ft. x 14 ft.
- Drilled Shafts: 3 ft. diameter, 23 ft. deep or 4 ft. diameter, 29 ft. deep

In addition, the standard foundation notes state the following requirements:

- All spread footings shall have an allowable design bearing pressure of 1 ¼ tons per square foot
- The drilled shafts have an allowable design lateral bearing pressure of 250 lbs. per square foot per foot of depth



Based on previous research, these requirements will be met in all but the weakest mineral soils, and therefore represent a very conservative design. In lieu of new foundation designs we checked the foundation soils to see if they met those requirements.

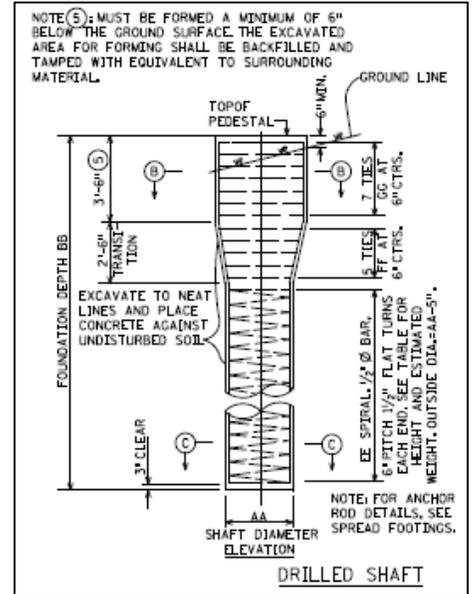


The recommendations contained in the paragraphs below are based on our analysis. We recommend the new foundations consist of drilled shafts designed to meet the requirements of the current standard design tables. At many locations casing used with a head of fluid will be needed to extend the shafts below the groundwater surface. If there are nearby utilities or structures temporary casing is recommended to protect them from ground movement.

Foundation Recommendations

Based on review of the existing subsurface conditions and proposed structures, we recommend:

1. The overhead sign structures be supported with drilled shaft foundations as detailed in the typical Foundation Detail Sheet, Drawing ST-3 located on the Traffic Engineering website.
2. Table 1 and the attached Overhead Sign Foundation Recommendations Table, showing the estimated soil and water conditions be forwarded along with a copy of the attached Boring and Sounding Logs to the bidding contractors.
3. That excavations extending below groundwater be temporarily cased to prevent caving and undermining of nearby structures and pavements and that the casing be removed as the concrete is placed.
4. Temporary casing be used to support excavation sides that are near structures or existing utilities.



Attachments:

- Overhead Sign Foundation Recommendations Table
- Exploration Plan and X-Section Sketches - 8 Sheets
- Boring Logs T01, T03, T04, T05, T06, T07, TC-2 (1969) Unique Numbers 82770, 82713, 82714, 82769, 82715, 82716
- Sounding Logs C02, C08, C08a, C09, Unique Numbers 82817, 82796, 82824, 82818
- SPT Index
- CPT Index

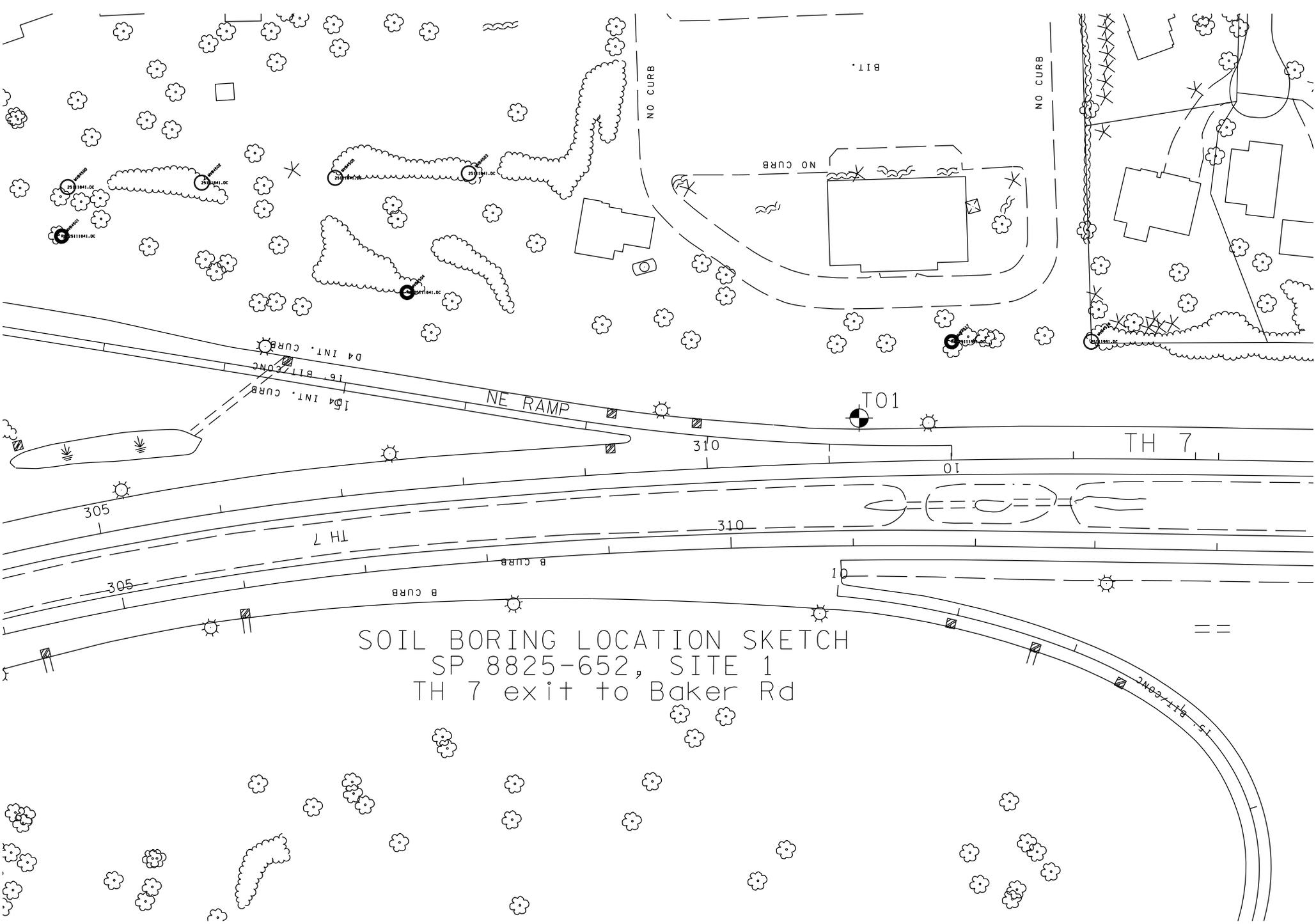
- cc: J. Tayse, Signing Engineer
 E. Peterson, Metro Signing Design
 E. Embacher, Construction Engineer
 M. Waters, Environmental Stewardship
 B. Skow, Chief Geotechnical Engineer



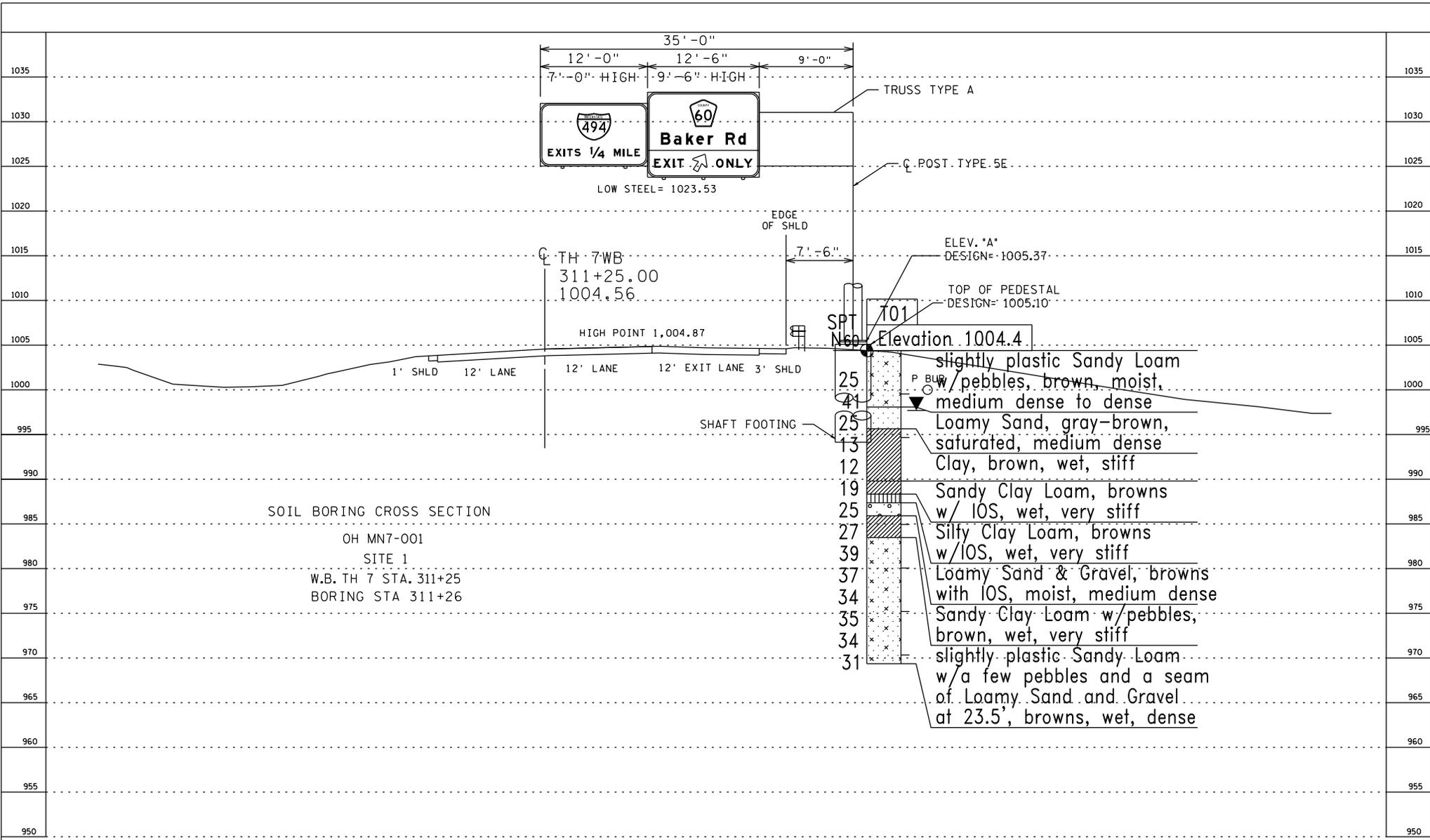
SP 8825-652, Various Metro State Highways, Overhead Sign Foundation Recommendations

| Current Plan | ID | Roadway Type | Direction | New Structure Station | Exploration Points | Exploration Locations | Post Locations | Soils | Ground Water | Recommendations |
|---------------------------------|-----------|--------------|-----------|--|--------------------|---------------------------------|--------------------|--|--------------|---|
| NEW CANTILEVER, SITE 1, TH 7 | MN7-001 | RAMP | WB | Ramp to NB US Baker Road, STA 311+25, 110' west of existing sign | T01 | 311+26, 36'Lt | SHOULDER | Sandy Loam and Sand to 9', Clays and Silts to 16.5', then Sandy Loam and Clay Loam with layers of Sand & Gravel. | 6.9' | Suitable for Standard Design, but temporary casing with a head of fluid should be used to extend the shaft into groundwater. |
| NEW CANTILEVER, SITE 7, TH 36 | MN36-090 | RAMP | EB | Ramp to SB TH 694, STA 61+45, 25' east of existing sign | C02 | 61+52, 26' Rt | SHOULDER | Frozen soils and Sands to 7', layered Silts, Clays and Sands to about 25', Sandy Loam and Sands to 36' | *6.5 | Suitable for Standard Design, but temporary casing with a head of fluid should be used to extend the shaft into groundwater. |
| NEW SIGN BRIDGE, SITE 8 TH 47 | MN47-004 | MAINLINE | SB | TH 47 STA 523+75, 50' south of existing sign | T03 T04 | 523+79, 43'Rt 523+81, 20'Lt | SHOULDER MEDIAN | Fine and very fine Sands | 8.5 11.2 | Suitable for Standard Design, but temporary casing with a head of fluid should be used to extend the shafts into groundwater. |
| NEW CANTILEVER, SITE 9, TH 94 | I94-688 | MAINLINE | WB | 2118+30, 30' southeast of existing sign | T05 | 2118+46, 31' Lt | SHOULDER | Silt Loam to 10', Sandy Loam to 11.5' and Sand & Gravel to 36' | -- | Suitable for Standard Design |
| NEW SIGN BRIDGE, SITE 10, TH 94 | I94-689 | MAINLINE | WB | 428+50, 250' south of existing sign | T06 T07 | 428+52, 52'Lt 428+55, 28' Rt | MEDIAN SHOULDER | Sands with Clay and Silt layers. | Below 810 | Suitable for Standard Design |
| NEW CANTILEVER, SITE 11, TH 100 | MN100-142 | MAINLINE | NB | 182+80, 30' north of existing sign | C08a C08 | 183+01, 42'Rt 183+83, 40'Rt | SHOULDER | Layered Clays, Sands and Silts to 10.5'. Refusal on dense Sand | --* | Suitable for Standard Design, but temporary casing with a head of fluid should be used to extend the shafts into groundwater. |
| NEW CANTILEVER, SITE 12, TH 100 | MN100-143 | MAINLINE | SB | 227+13, 25' South of existing sign bridge | C09 | 227+10, 32'Lt | SHOULDER | Sands with Clay and Silt layers to 29.5'. Refusal on dense Sand | --* | Suitable for Standard Design, but temporary casing with a head of fluid might be needed to extend the shaft into groundwater. |
| NEW CANTILEVER, SITE 13, TH 280 | MN280-023 | MAINLINE | NB | 88+60, 25' south of existing sign | TC-2 (1969) | NEAR 88+60 | SHOULDER | Sandy Loam to 13', then Sand & Gravel to 34' | 25 | Suitable for Standard Design, but temporary casing with a head of fluid should be used to extend the shaft into groundwater. |

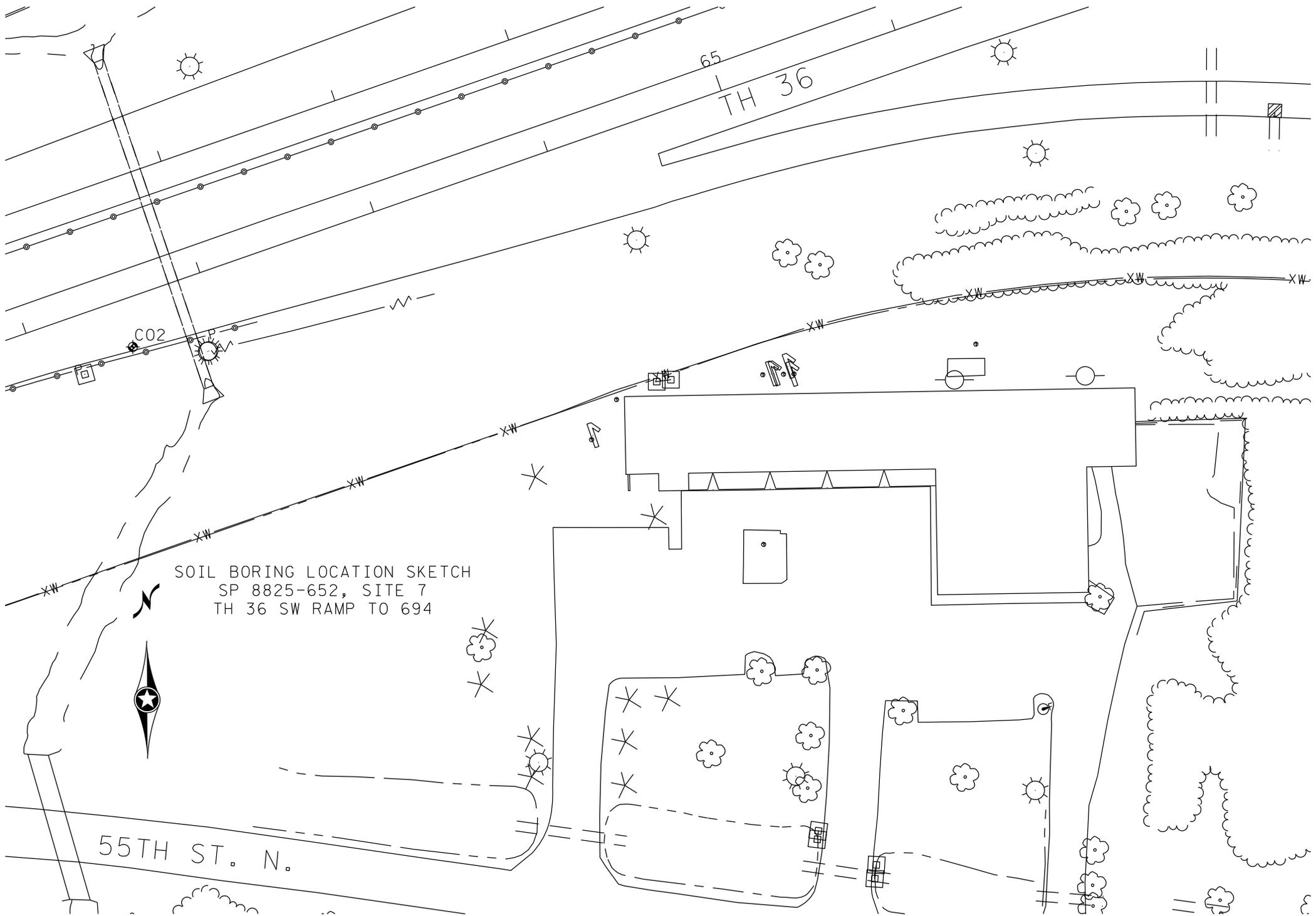
*= Perched groundwater layers may occur and may require the use of temporary casing.



SOIL BORING LOCATION SKETCH
 SP 8825-652, SITE 1
 TH 7 exit to Baker Rd



OH MN7-001



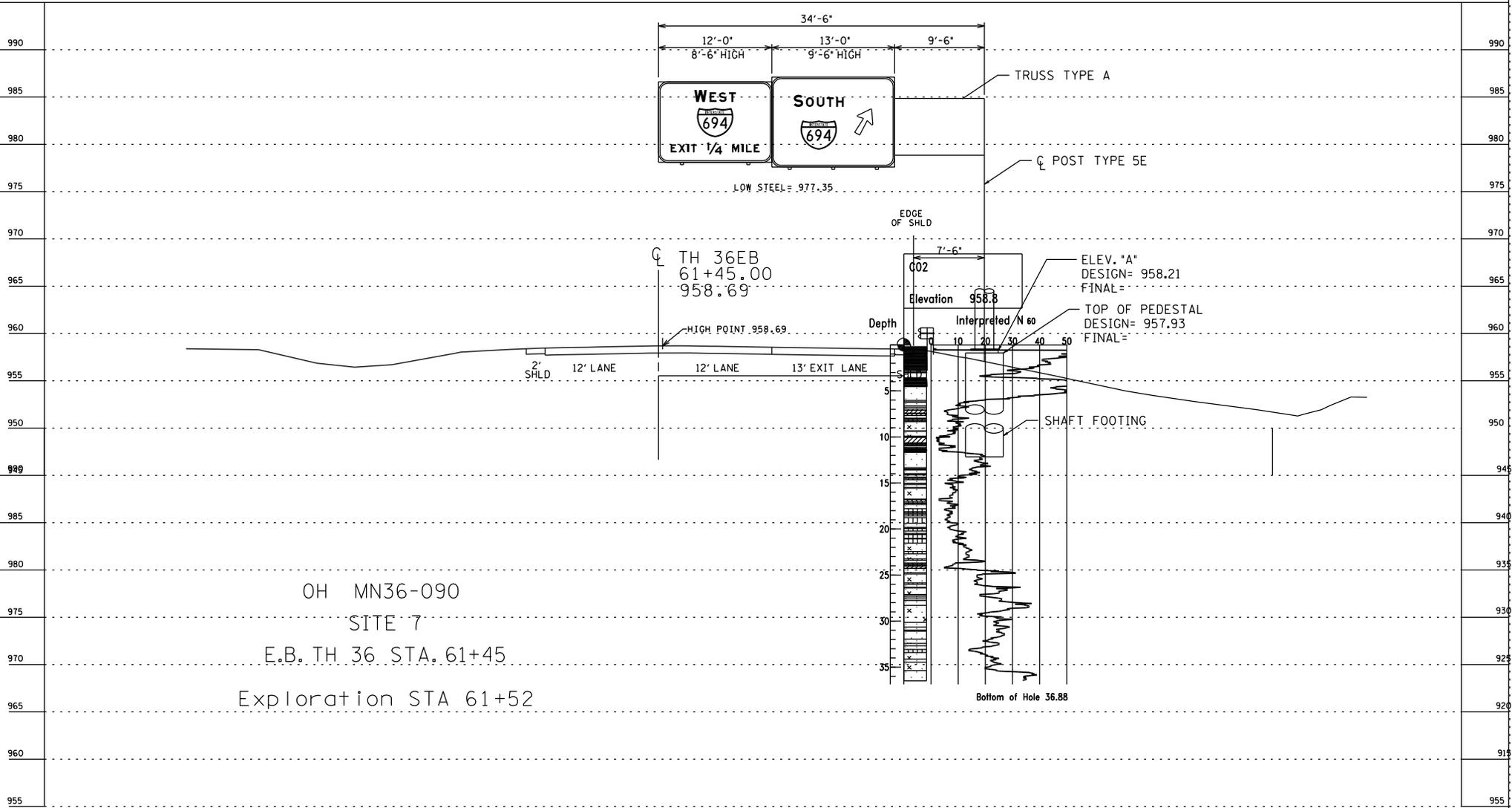
SOIL BORING LOCATION SKETCH
SP 8825-652, SITE 7
TH 36 SW RAMP TO 694

55TH ST. N.

65
TH 36

C02

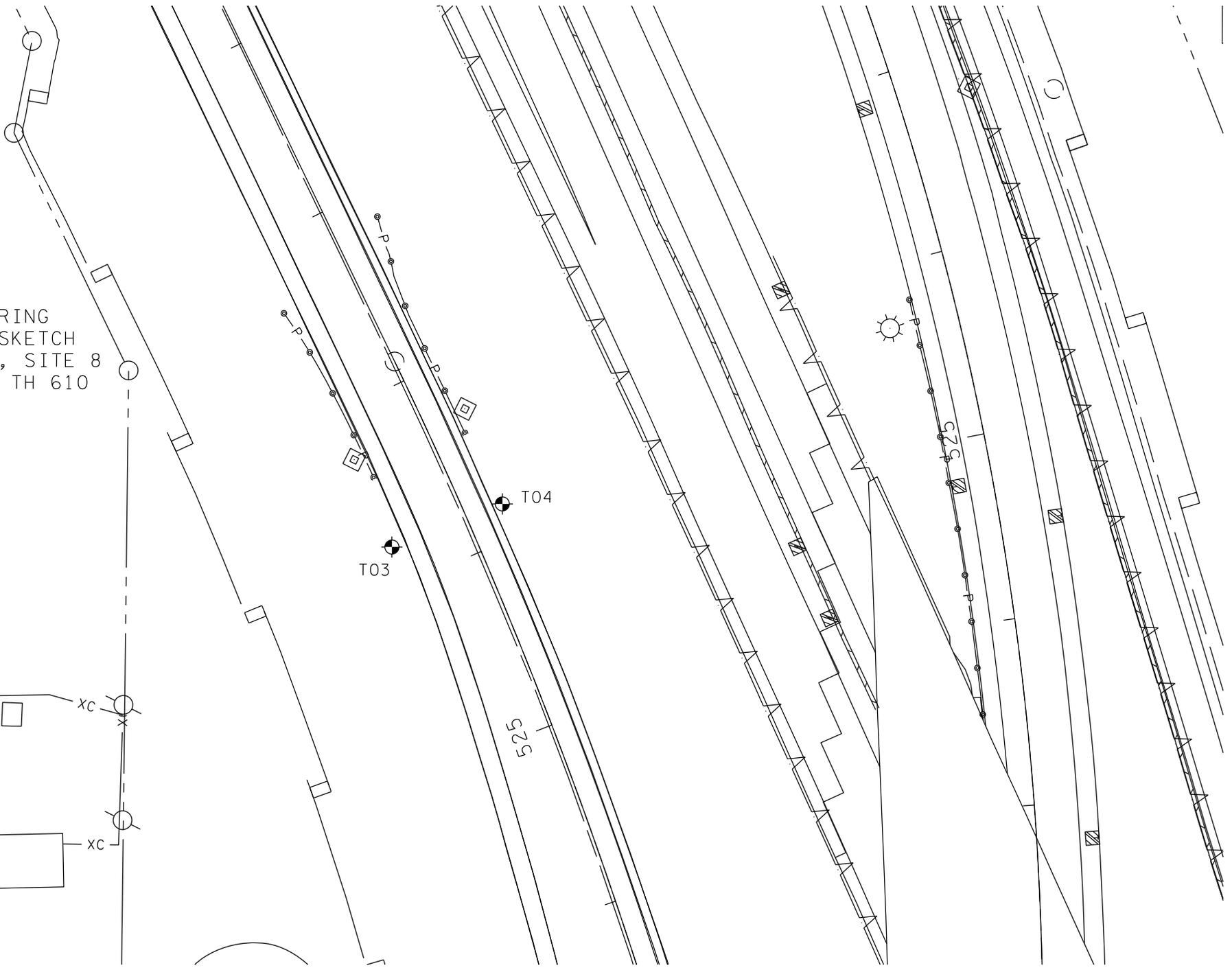
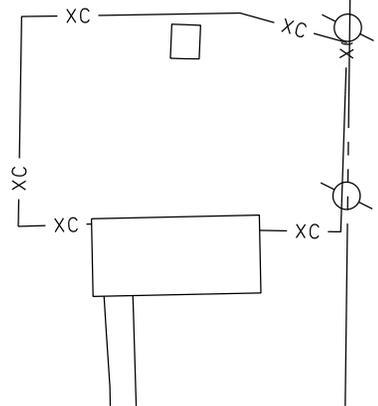
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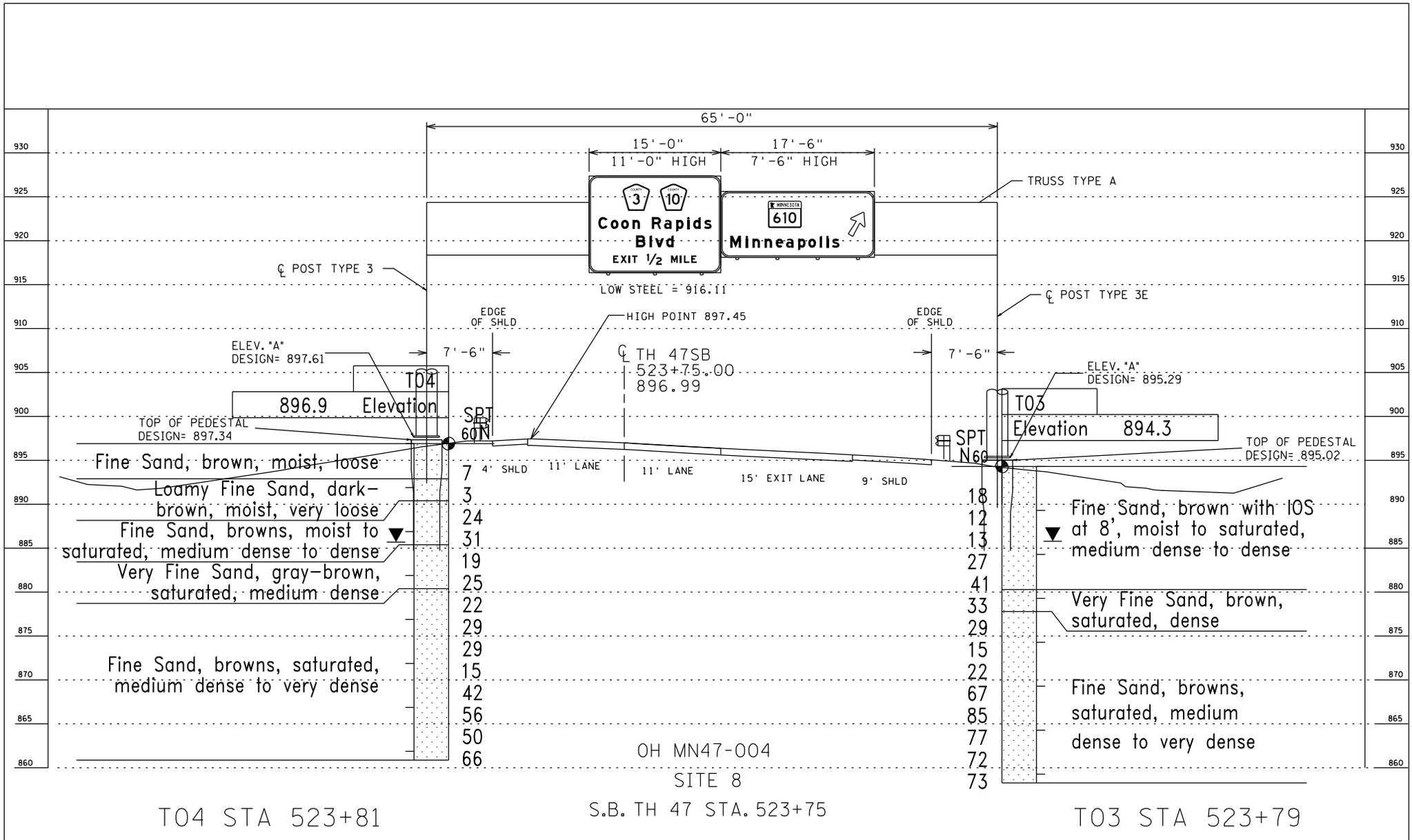


OH MN36-090
 SITE 7
 E.B. TH 36 STA. 61+45
 Exploration STA 61+52

OH MN36-090

SOIL BORING
LOCATION SKETCH
SP 8825-652, SITE 8
TH 47 near TH 610



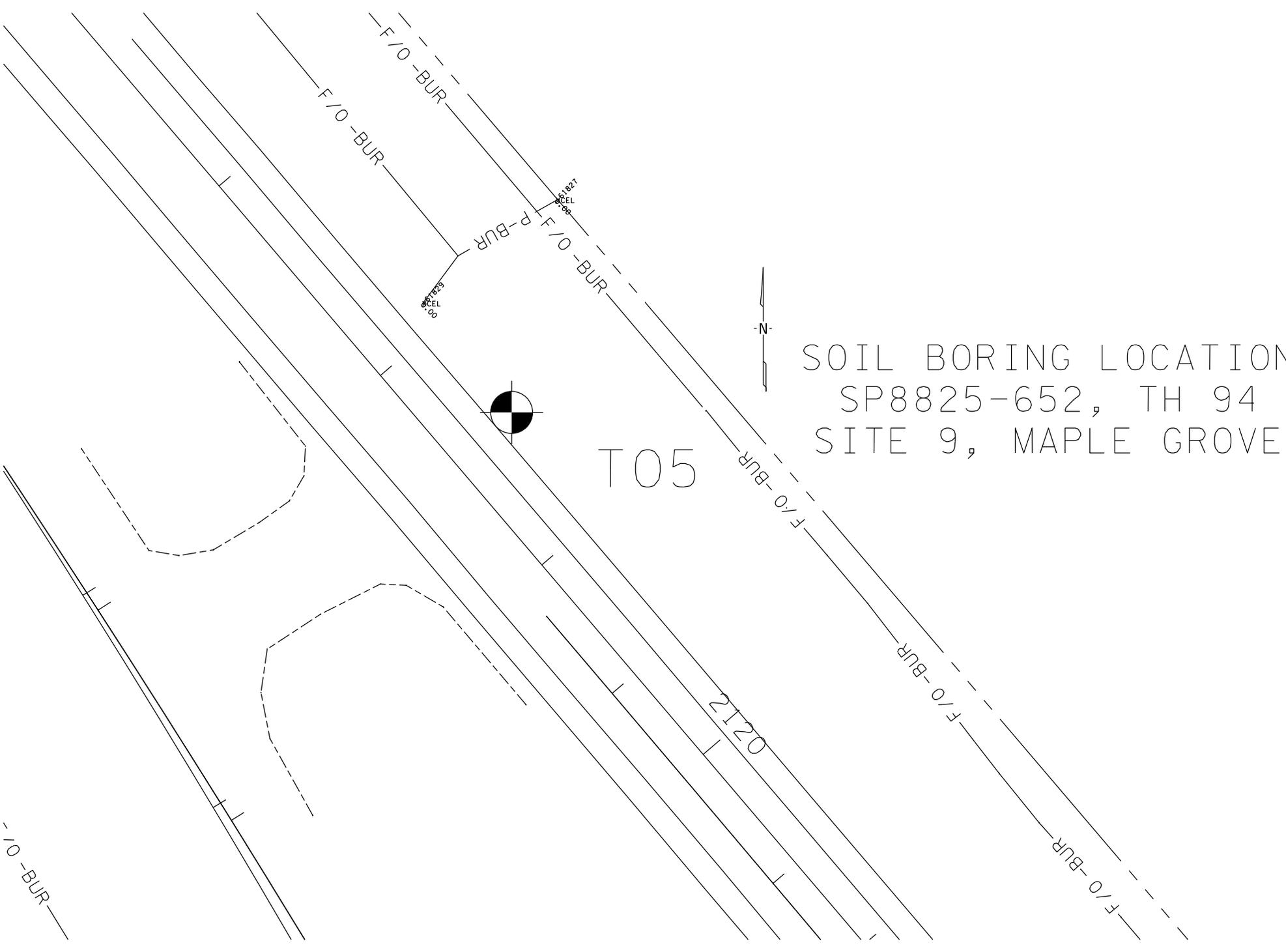


T04 STA 523+81

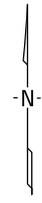
S.B. TH 47 STA. 523+75

T03 STA 523+79

OH MN47-004



SOIL BORING LOCATION
SP8825-652, TH 94
SITE 9, MAPLE GROVE



T05

21120
2120

F/O-BUR
F/O-BUR

F/P-BUR
F/O-BUR

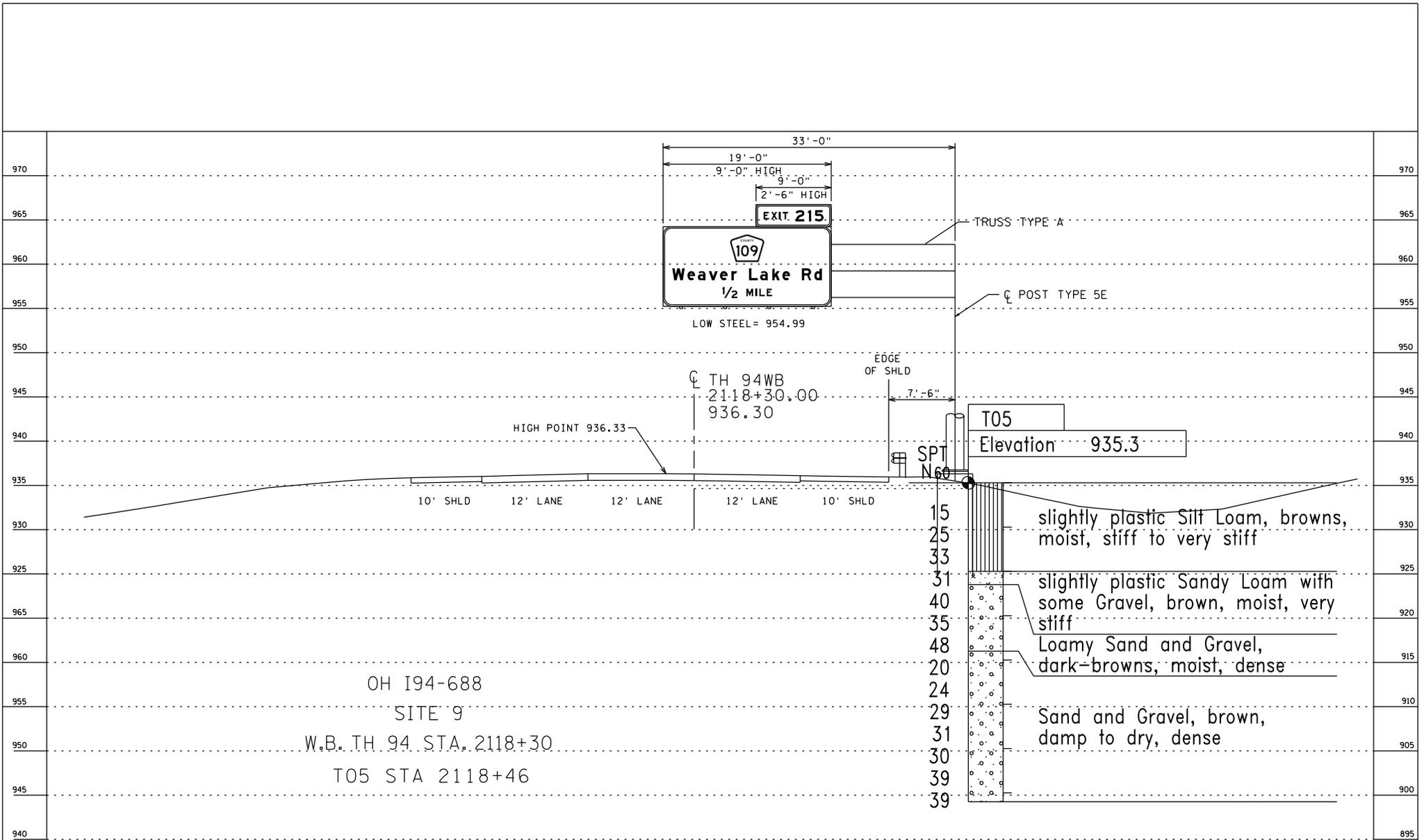
F/O-BUR

F/O-BUR

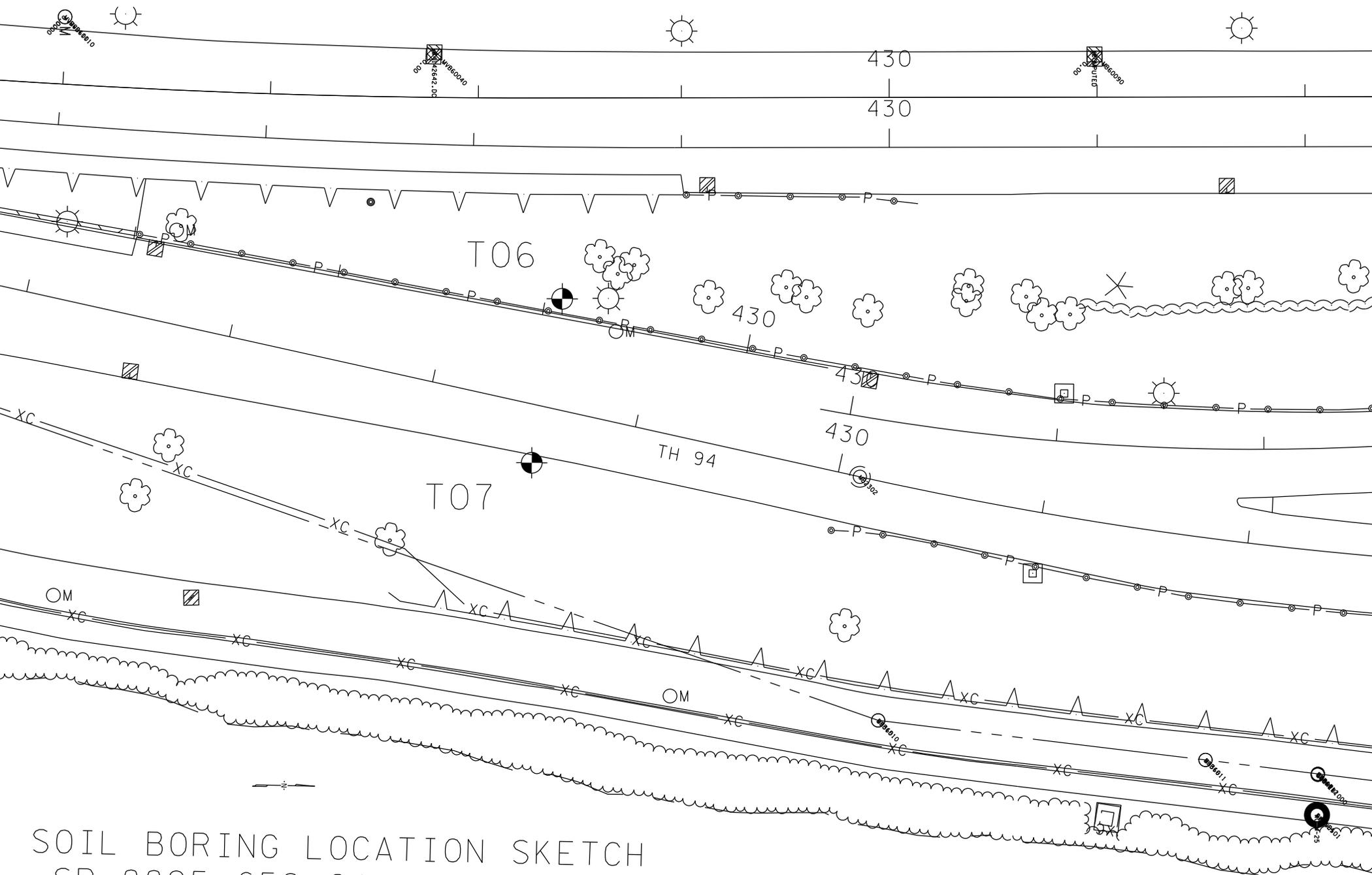
F/O-BUR

CELL
100

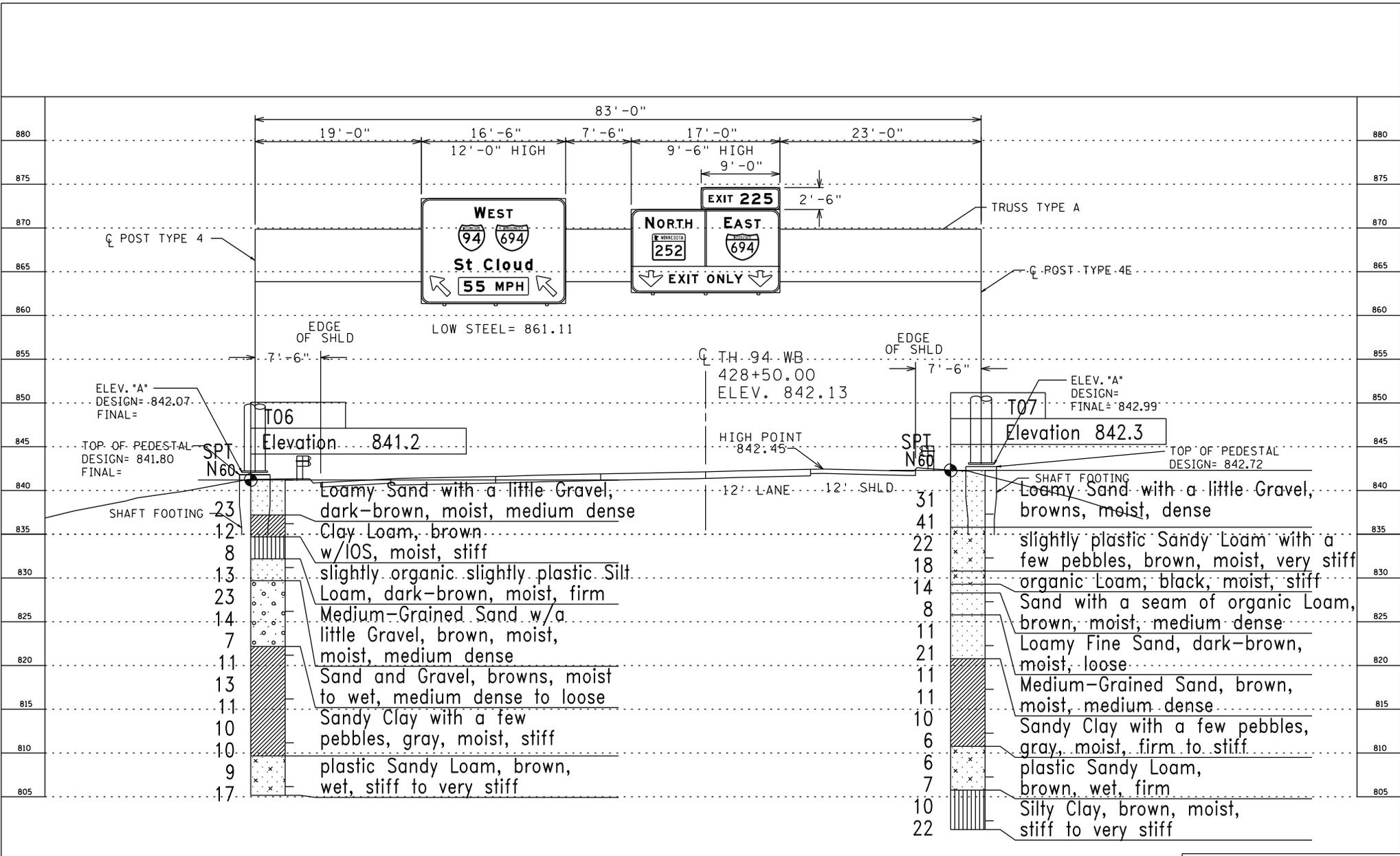
CELL
101



OH I94-688

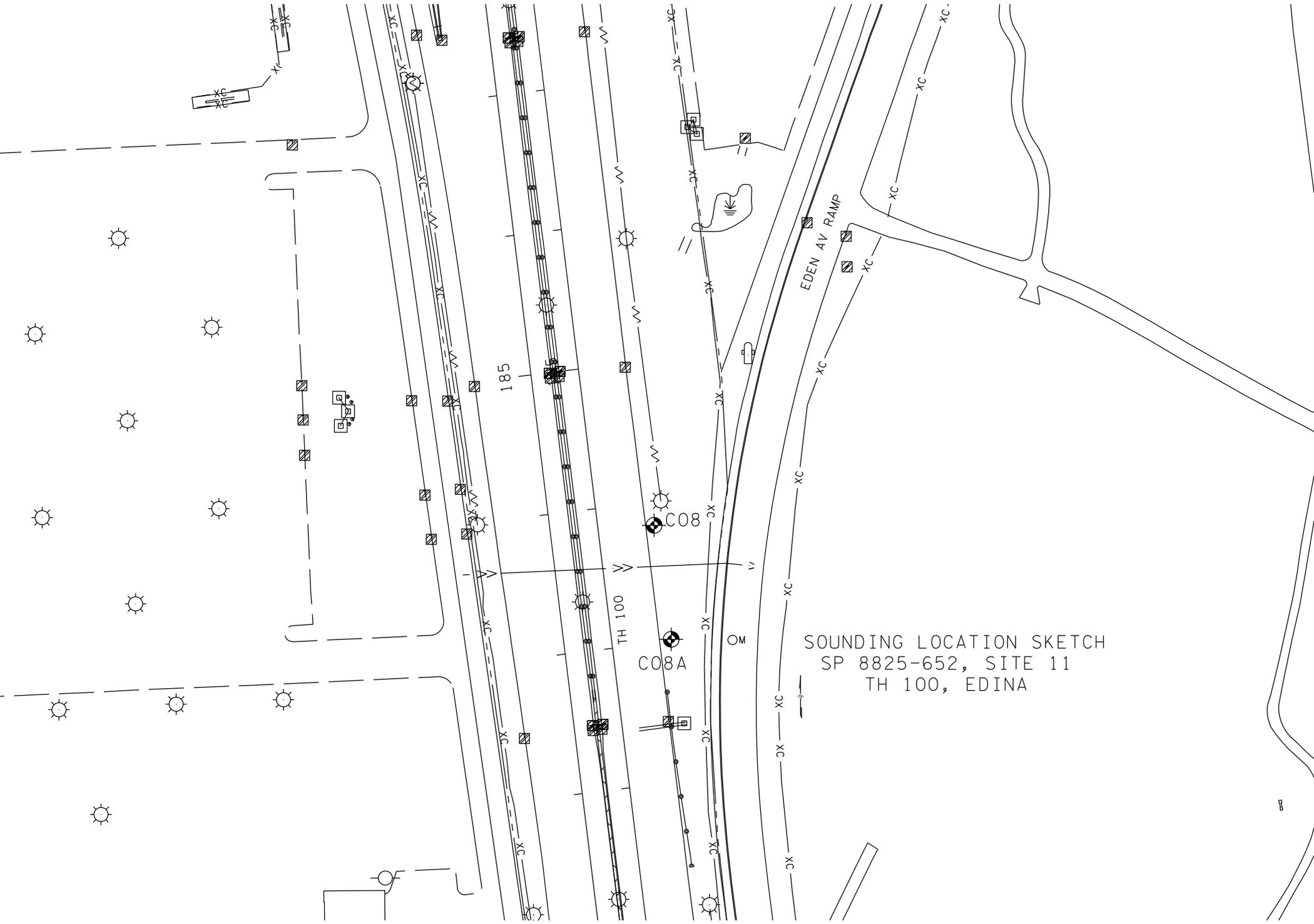


SOIL BORING LOCATION SKETCH
 SP 8825-652 Site 10, I-94
 Borings T06 and T07

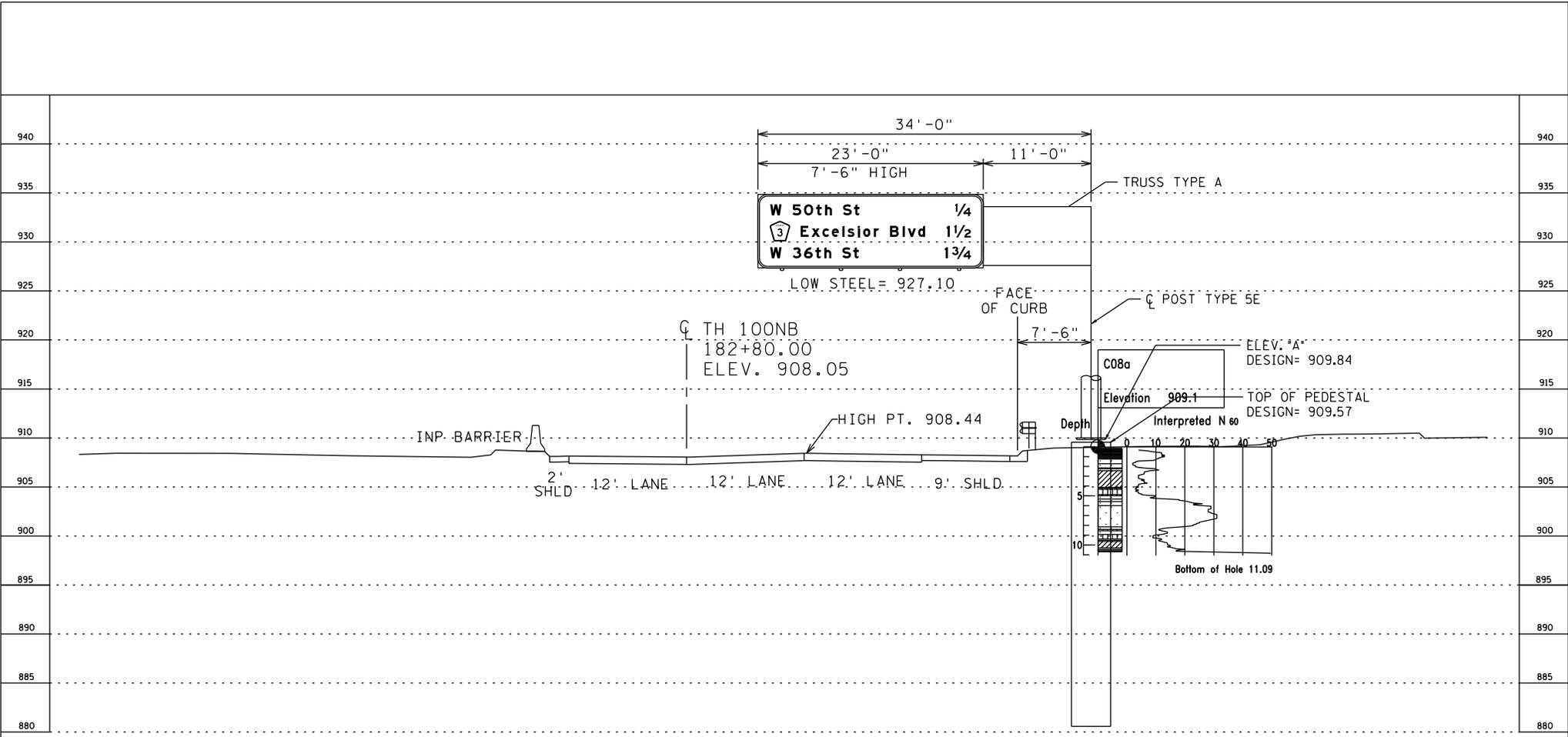


OH 194-689

SHEET NO. XX OF XX SHEETS

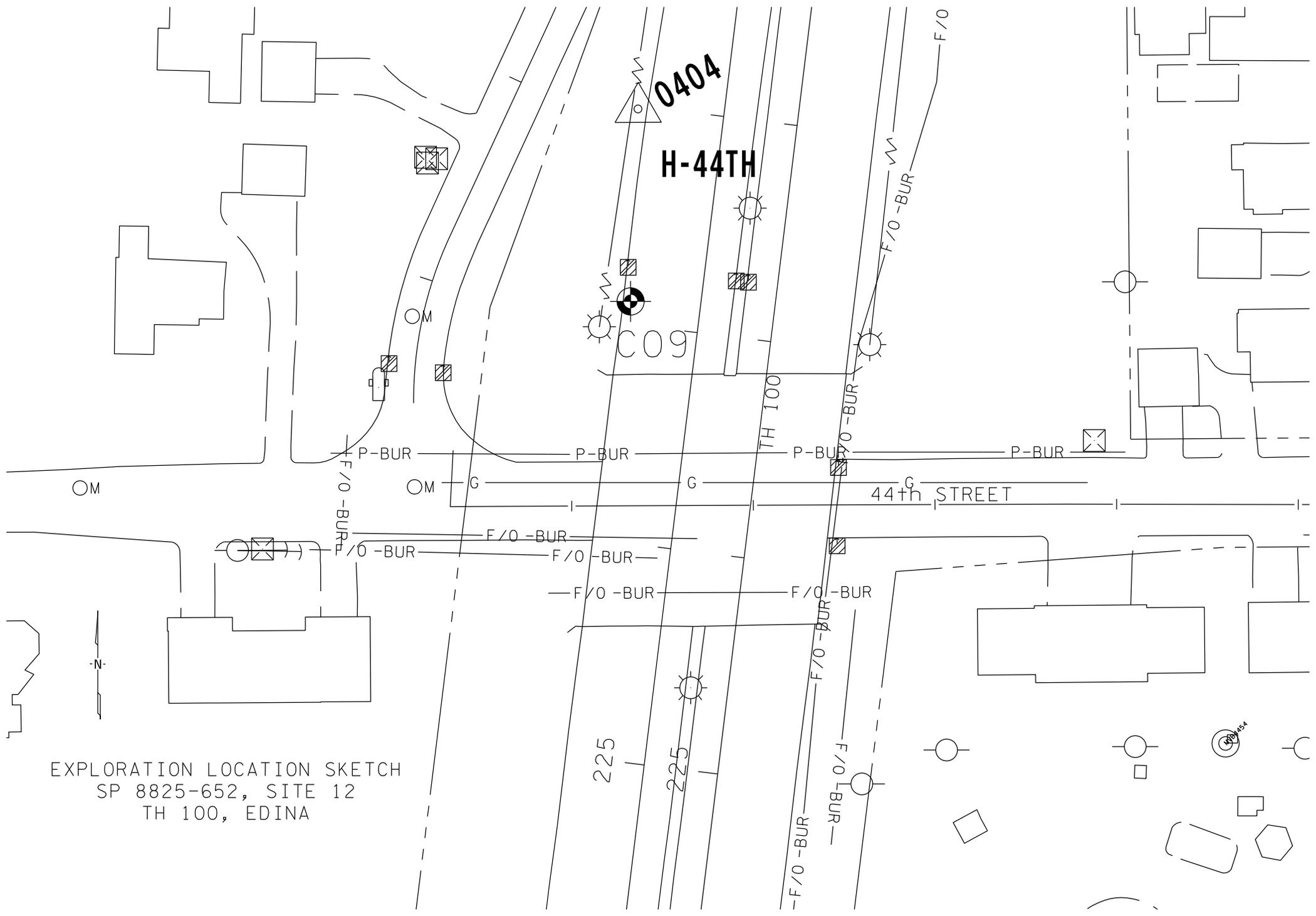


SOUNDING LOCATION SKETCH
 SP 8825-652, SITE 11
 TH 100, EDINA

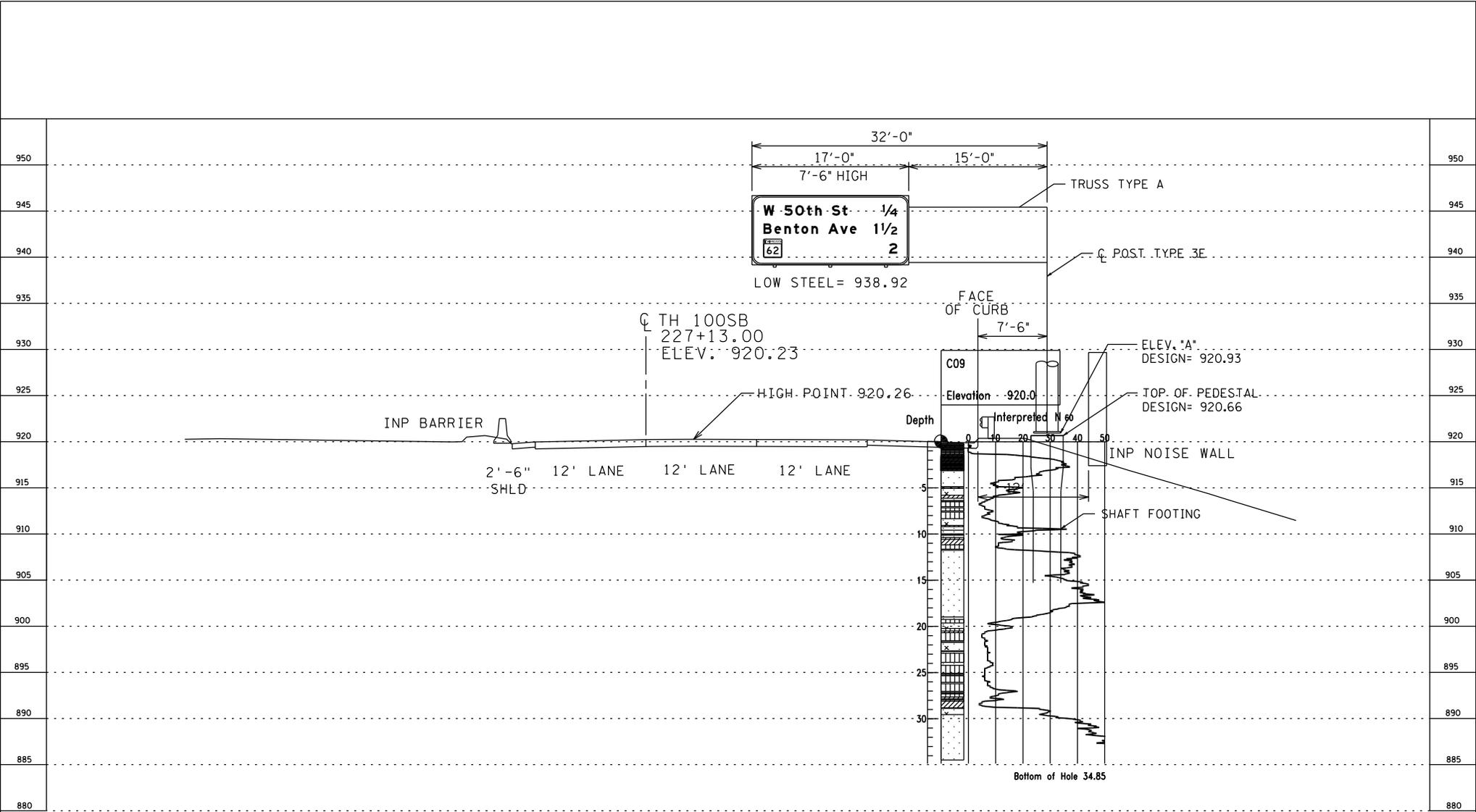


EXPLORATION LOCATION SKETCH
 OH MN100-142
 SITE 11
 N.B. TH 100 STA. 182+80
 C08a STA 183+01, 42'R+

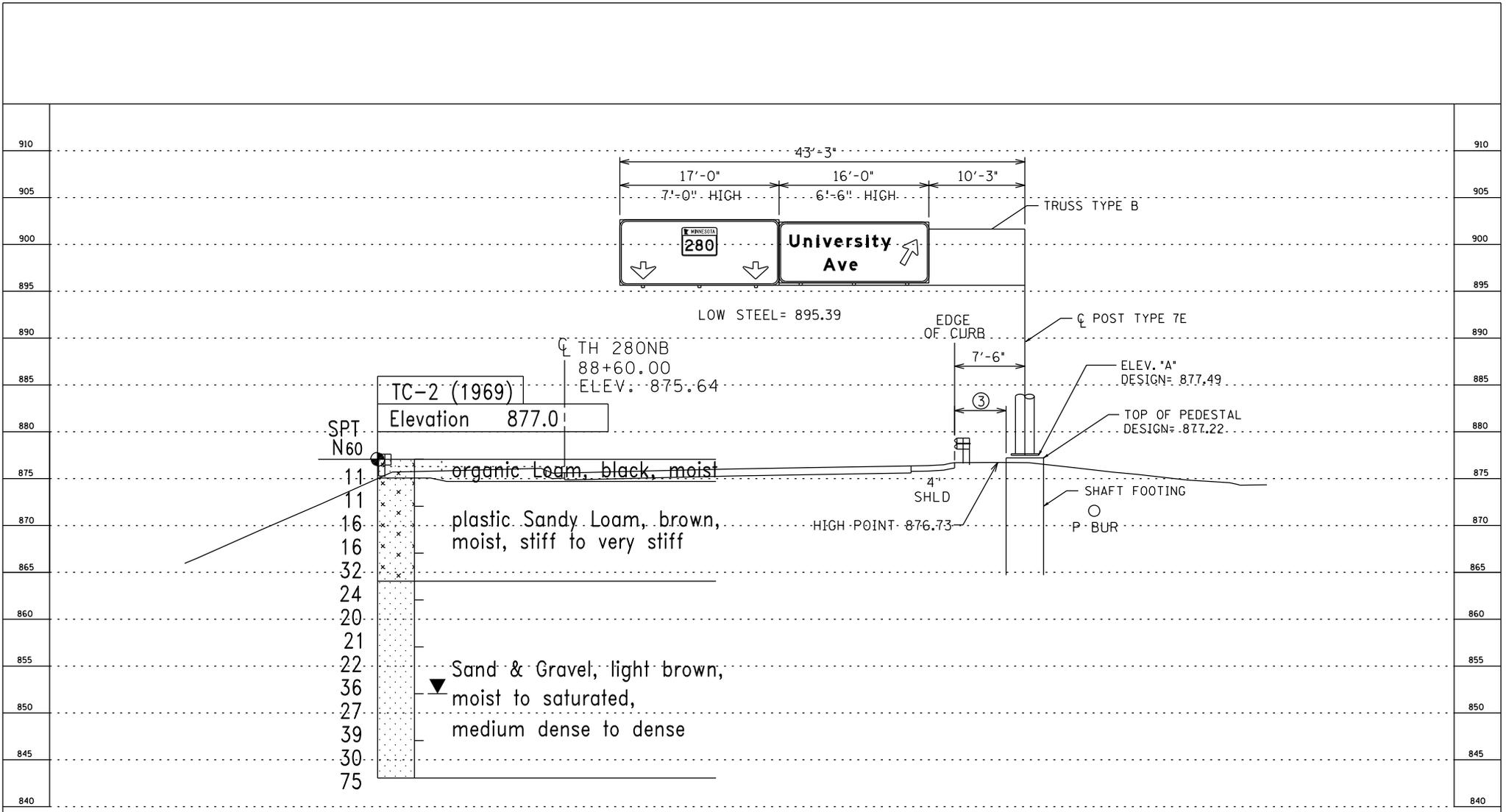
OH MN100-142



EXPLORATION LOCATION SKETCH
 SP 8825-652, SITE 12
 TH 100, EDINA



OH MN100-143



APPROXIMATE SOIL BORING LOCATION
 OH MN280-023
 SITE 13
 N.B. TH 280 STA. 88+60

OH MN280-023

UNIQUE NUMBER 82770

| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN MN7-001 | | Trunk Highway/Location Various Metro | | Boring No. T01 | | Ground Elevation 1004.4 (DTM) | | |
|--|---------------|---|----------------|--|-----|--|-------|---|------|----------------------------------|
| Location Ramsey County Coordinate System X=484330 Y=149353 TH 7 WB, STA 311+26, 36' Lt Latitude (North)=44°55'35.22" Longitude (West)=93°26'37.79" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 11/15/17 | | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT | MC | COH | γ | Soil | Other Tests |
| | Elev. | | | | N60 | (%) | (psf) | (pcf) | | Or Remarks |
| | | | | | REC | RQD | ACL | Core | | Formation |
| | | | | | (%) | (%) | (ft) | Breaks | | or Member |
| 5 | 6.5 997.9 | slightly plastic Sandy Loam with pebbles, brown, moist, medium dense to dense | | 25 | 11 | | | | | a little rough drilling 3.5', 7' |
| | 9.0 995.4 | Loamy Sand, gray-brown, saturated, medium dense | | 41 | 8 | | | | | |
| 10 | | Clay, brown, wet, stiff | | 25 | 15 | | | | | |
| | 15.0 989.4 | Sandy Clay Loam, browns with IOS, wet, very stiff | | 13 | 42 | | | | | |
| | 16.5 987.9 | Silty Clay Loam, browns with IOS, wet, very stiff | | 12 | 34 | | | | | |
| | 17.5 986.9 | Loamy Sand and Gravel, browns with IOS, moist, medium dense | | 19 | 19 | | | | | rough drilling at 15.8' |
| 20 | 19.0 985.4 | Sandy Clay Loam with pebbles, brown, wet, very stiff | | 25 | 33 | | | | | |
| | 21.5 982.9 | slightly plastic Sandy Loam with a few pebbles and a seam of Loamy Sand and Gravel at 23.5', browns, wet, dense | | 27 | 20 | | | | | rough drilling at 21.5' |
| 25 | | | | 39 | 17 | | | | | |
| | | | | 37 | 11 | | | | | |
| | | | | 34 | 14 | | | | | |
| 30 | | | | 35 | 13 | | | | | |
| | | | | 34 | 10 | | | | | |
| 35 | 36.0 968.4 | Bottom of Hole - 36.0' Water measured at 6.9' with auger | | 31 | 11 | | | | | |

UNIQUE NUMBER 82713

| | | | | | | | | | |
|---|---------------|---|--|------------------------|--|---|-----------|--|------------------------|
| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN MN47-004 SB Various Metro | | Trunk Highway/Location | | Boring No. T03 | | Ground Elevation 894.3 (DTM) | |
| Location Ramsey County Coordinate System X=528915 Y=229792 TH 47 SB, STA 523+79, 43Rt Latitude (North)=45°08'49.28" Longitude (West)=93°16'16.59" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 10/24/17 | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT N60 | MC (%) | COH (psf) | γ (pcf) | Other Tests Or Remarks |
| | Elev. | | | | REC (%) | RQD (%) | ACL (ft) | Core Breaks |  | Soil / Rock |
| | | | Fine Sand, brown with IOS at 8', moist to saturated, medium dense to dense | | 18 12 13 27 41 33 29 15 22 67 85 77 72 73 | 9 17 21 20 19 25 24 24 17 22 21 21 20 22 | | | |
| | 14.0 880.3 | | Very Fine Sand, brown, saturated, dense | | | | | | |
| | 16.5 877.8 | | Fine Sand, browns, saturated, medium dense to very dense | | | | | | |
| | 36.0 858.3 | | Bottom of Hole - 36.0' Water measured at 8.5' with auger | | | | | | |

UNIQUE NUMBER 82714

| | | | | | | | | | |
|--|---------------|---|--|------------------------|---------|--|-----------|--|------------------------|
| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN MN47-004 NB Various Metro | | Trunk Highway/Location | | Boring No. T04 | | Ground Elevation 896.9 (DTM) | |
| Location Ramsey County Coordinate System X=528974 Y=229815 TH 47 SB, STA 523+81, 20'Lt Latitude (North)=45°08'49.51" Longitude (West)=93°16'15.76" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 10/25/17 | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT N60 | MC (%) | COH (psf) | γ (pcf) | Other Tests Or Remarks |
| | Elev. | | | | REC (%) | RQD (%) | ACL (ft) | Core Breaks |  | Formation or Member |
| | 4.0 892.9 | [Dotted pattern] | Fine Sand, brown, moist, loose | [Symbol] | 7 | 7 | | | |
| 5 | 6.5 890.4 | | Loamy Fine Sand, dark-brown, moist, very loose | [Symbol] | 3 | 12 | | | |
| | 11.5 885.4 | [Dotted pattern] | Fine Sand, browns, moist to saturated, medium dense to dense | [Symbol] | 24 | 11 | | | |
| 10 | 16.5 880.4 | | Very Fine Sand, gray-brown, saturated, medium dense | [Symbol] | 31 | 17 | | | |
| | | [Dotted pattern] | Fine Sand, browns, saturated, medium dense to very dense | [Symbol] | 19 | 26 | | | |
| 15 | | | | [Symbol] | 25 | 24 | | | |
| | | | | [Symbol] | 22 | 24 | | | |
| 20 | | | | [Symbol] | 29 | 24 | | | |
| | | | | [Symbol] | 29 | 25 | | | |
| 25 | | | | [Symbol] | 15 | 24 | | | |
| | | | | [Symbol] | 42 | 22 | | | |
| 30 | | | | [Symbol] | 56 | 23 | | | |
| | | | | [Symbol] | 50 | 22 | | | |
| 35 | | | | [Symbol] | 66 | 23 | | | |

Bottom of Hole - 36.0'
Water measured at 11.2' with auger

UNIQUE NUMBER 82769

| | | | | | | | | | | |
|---|--------------------------------|--|--|--|---------------------|--|--------------------------|------------------------------------|--|--|
| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN I-94-688 | | Trunk Highway/Location Various Metro | | | Boring No. T05 | | Ground Elevation 935.3 (DTM) | |
| Location Ramsey County Coordinate System X=482615 Y=211587 TH 94 EB STA 2118+46, 31' Lt Latitude (North)=45°05'49.67" Longitude (West)=93°27'02.34" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 11/14/17 | | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT N ₆₀ | MC (%) | COH (psf) | γ (pcf) | Soil/Rock | Other Tests Or Remarks |
| | Elev. | | | | REC (%) | RQD (%) | ACL (ft) | Core Breaks | | Formation or Member |
| | 5 | | slightly plastic Silt Loam, browns, moist, stiff to very stiff | | 15 | 18 | | | | |
| | 10.0 925.3 11.5 923.8 | | slightly plastic Sandy Loam with some Gravel, brown, moist, very stiff | | 25 | 19 | | | | |
| | 15 | | Loamy Sand and Gravel, dark-browns, moist, dense | | 33 | 15 | | | | |
| | 19.0 916.3 | | Sand and Gravel, brown, damp to dry, dense | | 31 | 13 | | | | a little rougher drilling 11.5' to 36' |
| | 20 | | | | 40 | 8 | | | | |
| | 25 | | | | 35 | 6 | | | | |
| | 30 | | | | 48 | 4 | | | | |
| | 35 | | | | 20 | 2 | | | | |
| | 36.0 899.3 | | Bottom of Hole - 36.0' No water encountered or measured during drilling | | 24 | 2 | | | | |
| | | | | | 29 | 1 | | | | |
| | | | | | 31 | 1 | | | | |
| | | | | | 30 | 1 | | | | |
| | | | | | 39 | 1 | | | | |
| | | | | | 39 | 1 | | | | |

UNIQUE NUMBER 82715

| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN I94-689 | | Trunk Highway/Location Various Metro | | | Boring No. T06 | | Ground Elevation 841.2 (DTM) | |
|---|---------------|--|--|--|-----|--|--------------------------|------------------------------------|--|-------------------------------------|
| Location Ramsey County Coordinate System X=525191 Y=199719 TH 94 WB, STA 428+52, 52Lt Latitude (North)=45°03'52.41" Longitude (West)=93°17'09.05" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 10/26/17 | | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT | MC | COH | γ | Soil | Other Tests |
| | Elev. | | | | N60 | (%) | (psf) | (pcf) | | Or Remarks |
| | | | | | REC | RQD | ACL | Core Breaks | Rock | Formation or Member |
| | 4.0 837.2 | Loamy Sand with a little Gravel, dark-brown, moist, medium dense | | | 23 | 7 | | | | |
| 5 | 6.5 834.7 | Clay Loam, brown with IOS, moist, stiff | | | 12 | 15 | | | | |
| | 9.0 832.2 | slightly organic slightly plastic Silt Loam, dark-brown, moist, firm | | | 8 | 19 | | | | |
| 10 | 11.5 829.7 | Medium-Grained Sand with a little Gravel, brown, moist, medium dense | | | 13 | 6 | | | | |
| 15 | | Sand and Gravel, browns, moist to wet, medium dense to loose | | | 23 | 5 | | | | a little rough drilling 11.5' - 19' |
| | 19.0 822.2 | | | | 14 | 7 | | | | |
| | | | | | 7 | 8 | | | | |
| 20 | | | | | 11 | 17 | | | | |
| | | | | | 13 | 17 | | | | |
| 25 | | Sandy Clay with a few pebbles, gray, moist, stiff | | | 11 | 17 | | | | |
| | | | | | 10 | 15 | | | | |
| 30 | | | | | 10 | 16 | | | | |
| | 31.5 809.7 | | | | 9 | 14 | | | | |
| 35 | | plastic Sandy Loam, brown, wet, stiff to very stiff | | | 17 | 16 | | | | |
| | 36.0 805.2 | | Bottom of Hole - 36.0' No water encountered or measured during drilling | | | | | | | |

UNIQUE NUMBER 82716

| | | | | | | | | | |
|--|---------------|---|--|--|-----|--|-------|--|------------------------|
| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN I94-689 | | Trunk Highway/Location Various Metro | | Boring No. T07 | | Ground Elevation 842.3 (DTM) | |
| Location Ramsey County Coordinate System X=525270 Y=199704 TH 94 WB, STA 428+55, 28'Rt Latitude (North)=45°03'52.27" Longitude (West)=93°17'07.94" | | | | | | Drill Machine 211304 CME Fat Tire | | SHEET 1 of 1 | |
| | | | | | | Hammer CME Automatic Calibrated | | Drilling Completed 10/26/17 | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT | MC | COH | γ | Other Tests Or Remarks |
| | Elev. | | | | N60 | (%) | (psf) | (pcf) | |
| | | | | | REC | RQD | ACL | Core Breaks | Formation or Member |
| | | | | | (%) | (%) | (ft) | | |
| 5 | 6.5 835.8 | | Loamy Sand with a little Gravel, browns, moist, dense | | 31 | 6 | | | |
| | | | | | 41 | 7 | | | |
| 10 | 11.5 830.8 | | slightly plastic Sandy Loam with a few pebbles, brown, moist, very stiff | | 22 | 12 | | | |
| | | | | | 18 | 13 | | | |
| | 13.0 829.3 | | organic Loam, black, moist, stiff | | 14 | 13 | | | |
| | 14.0 828.3 | | Sand with a seam of organic Loam, brown, moist, medium dense | | | | | | |
| 15 | 16.5 825.8 | | Loamy Fine Sand, dark-brown, moist, loose | | 8 | 14 | | | |
| | | | | | 11 | 4 | | | |
| 20 | 21.5 820.8 | | Medium-Grained Sand, brown, moist, medium dense | | 21 | 5 | | | |
| | | | | | 11 | 18 | | | |
| 25 | | | Sandy Clay with a few pebbles, gray, moist, firm to stiff | | 11 | 17 | | | |
| | | | | | | 10 | 17 | | |
| | | | | | | 6 | 18 | | |
| 30 | 31.5 810.8 | | plastic Sandy Loam, brown, wet, firm | | 6 | 16 | | | |
| | | | | | | 7 | 16 | | |
| 35 | 36.5 805.8 | | Silty Clay, brown, moist, stiff to very stiff | | 10 | 19 | | | |
| | | | | | | 22 | 20 | | |
| 40 | 41.0 801.3 | | Bottom of Hole - 41.0' | | | | | | |
| | | | No water encountered or measured during drilling | | | | | | |

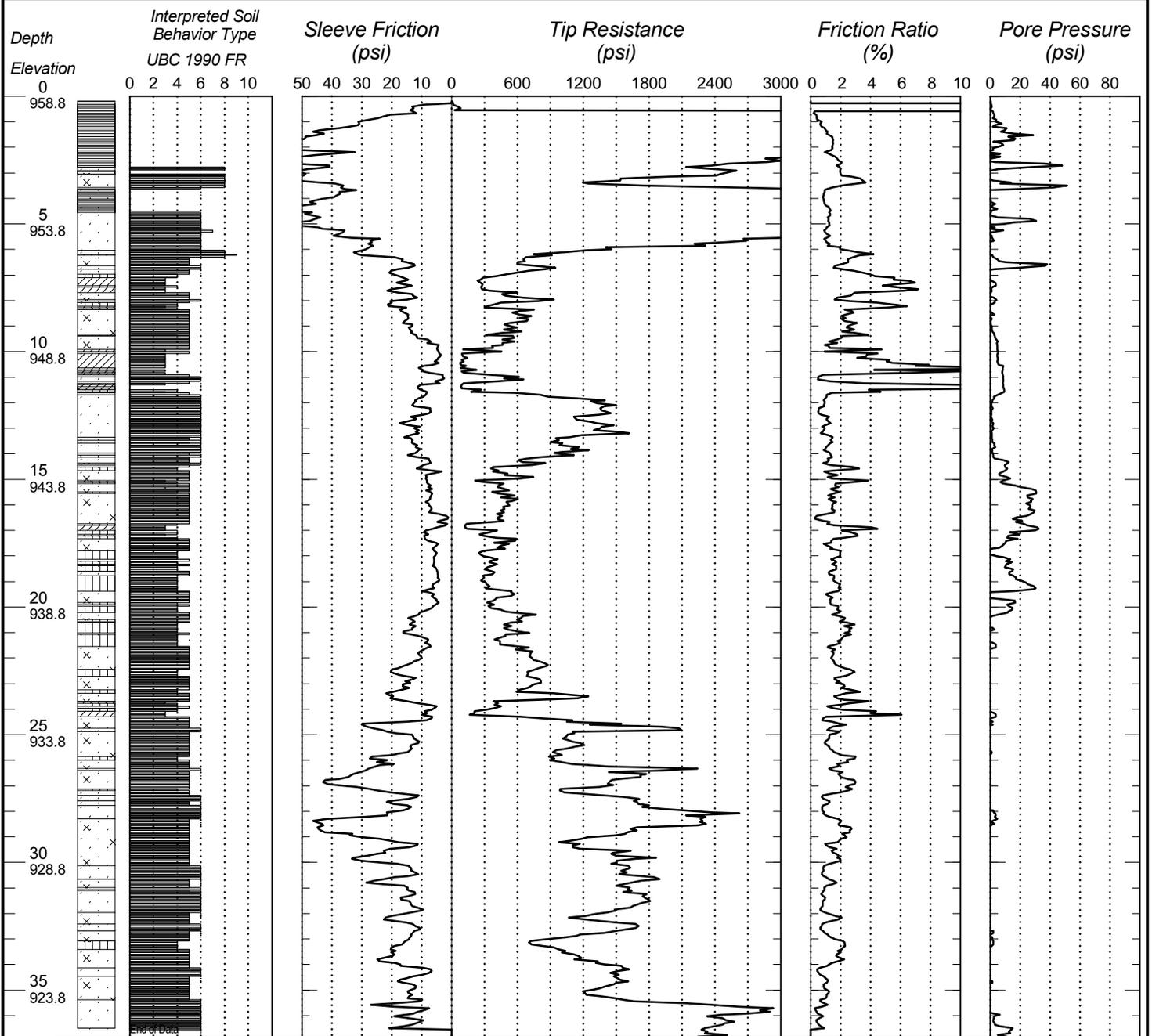
UNIQUE NUMBER 7174

| | | | | | | | | | | | |
|--|---------------|---|---|--|------------------------|--------------------------------------|----------------------------------|-------------------------------------|--|---------------------------|------------------------|
| State Project 8825-652 | | Bridge No. or Job Desc. OH SIGN MN280-023 | | Trunk Highway/Location Various Metro | | | Boring No. TC-2 (1969) | | Ground Elevation 877.0 (from Plan) | | |
| Location Ramsey County Coordinate System X= Y= Latitude (North)= Longitude (West)= <i>'SP 6242-41, STA 135+25, 20' Lt</i> | | | | | | Drill Machine Soil Sampler | | SHEET 1 of 1 | | | |
| | | | | | | Hammer Rope & Cathead | | Drilling Completed 4/9/69 | | | |
| DEPTH | Depth | Lithology | Classification | Drilling Operation | SPT N ₆₀ | MC (%) | COH (psf) | γ (pcf) | Soil | Other Tests Or Remarks | |
| | Elev. | | | | REC (%) | RQD (%) | ACL (ft) | Core Breaks | | Rock | Formation or Member |
| | 2.0 875.0 | organic Loam, black, moist | | 11 | | | | | | | |
| 5 | | | plastic Sandy Loam, brown, moist, stiff to very stiff | | | 11 | | | | | |
| | | | | 16 | | | | | | | |
| 10 | | | | | 16 | | | | | | |
| | | Sand & Gravel, light brown, moist to saturated, medium dense to dense | | | | | 32 | | | | |
| | 13.0 864.0 | | | 24 | | | | | | | |
| 15 | | | | | 20 | | | | | | |
| | | | | 21 | | | | | | | |
| 20 | | | 22 | | | | | | | | |
| | | | | 36 | | | | | | | |
| 25 | | | 27 | | | | | | | | |
| | | | | 39 | | | | | | | |
| 30 | | | 30 | | | | | | | | |
| | | | | 75 | | | | | | | |
| | 34.0 843.0 | | | | | | | | | Stone in sampler tip. | |
| Bottom of Hole - 34' Water measured at 25' with auger | | | | | | | | | | | |

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82817

| | | | | |
|---|--|--|----------------------------|---|
| State Project 8825-652 | Bridge No. or Job Desc. OH SIGN MN36-090 | Trunk Highway/Location Various Metro | Sounding No. C02 | Ground Elevation 958.8 (GeoXH (DC)) |
| Location Ramsey County Coordinate System X=607466 Y=186737 | | CPT Machine 203094 CPT Truck | | SHEET 1 of 1 |
| Latitude (North)=45°01'41.67" | | CPT Operator ODonnell | | Date Completed |
| Longitude (West)=92°58'03.75" | | Hole Type CPT-STD | | 12/7/17 |

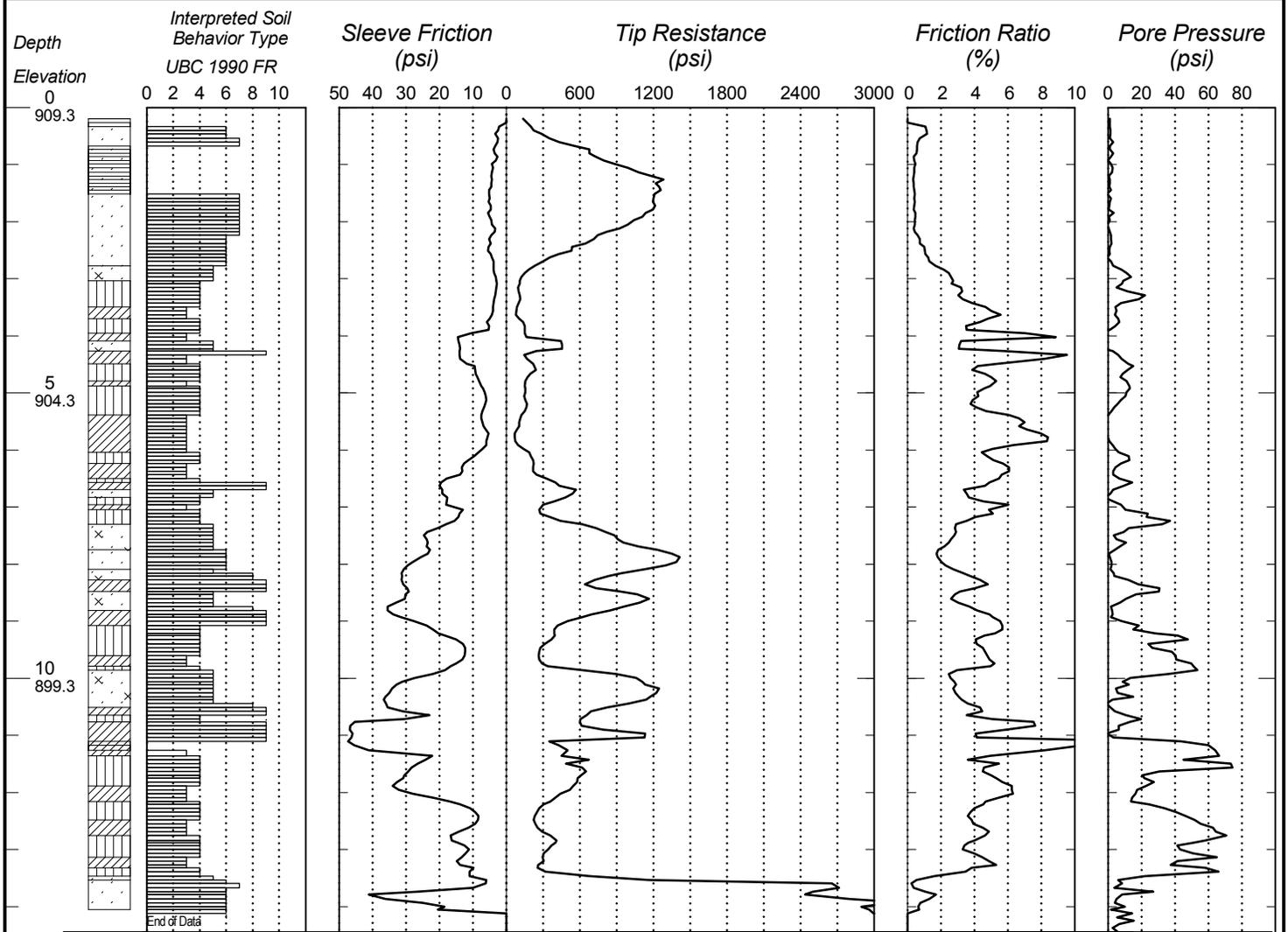


Bottom of Hole 36.88

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82796

| | | | | |
|---|---|--|----------------------------|--|
| State Project 8825-652 | Bridge No. or Job Desc. OH SIGN MN100-142 | Trunk Highway/Location Various Metro | Sounding No. C08 | Ground Elevation 909.3 (DTM) |
| Location Ramsey County Coordinate System X=508631 Y=142329 | | CPT Machine 203094 CPT Truck | | SHEET 1 of 1 |
| | | CPT Operator O'Donnell | | Date Completed |
| Latitude (North)=44°54'25.92" Longitude (West)=93°21'00.08" | | Hole Type CPT-STD | | 11/29/17 |

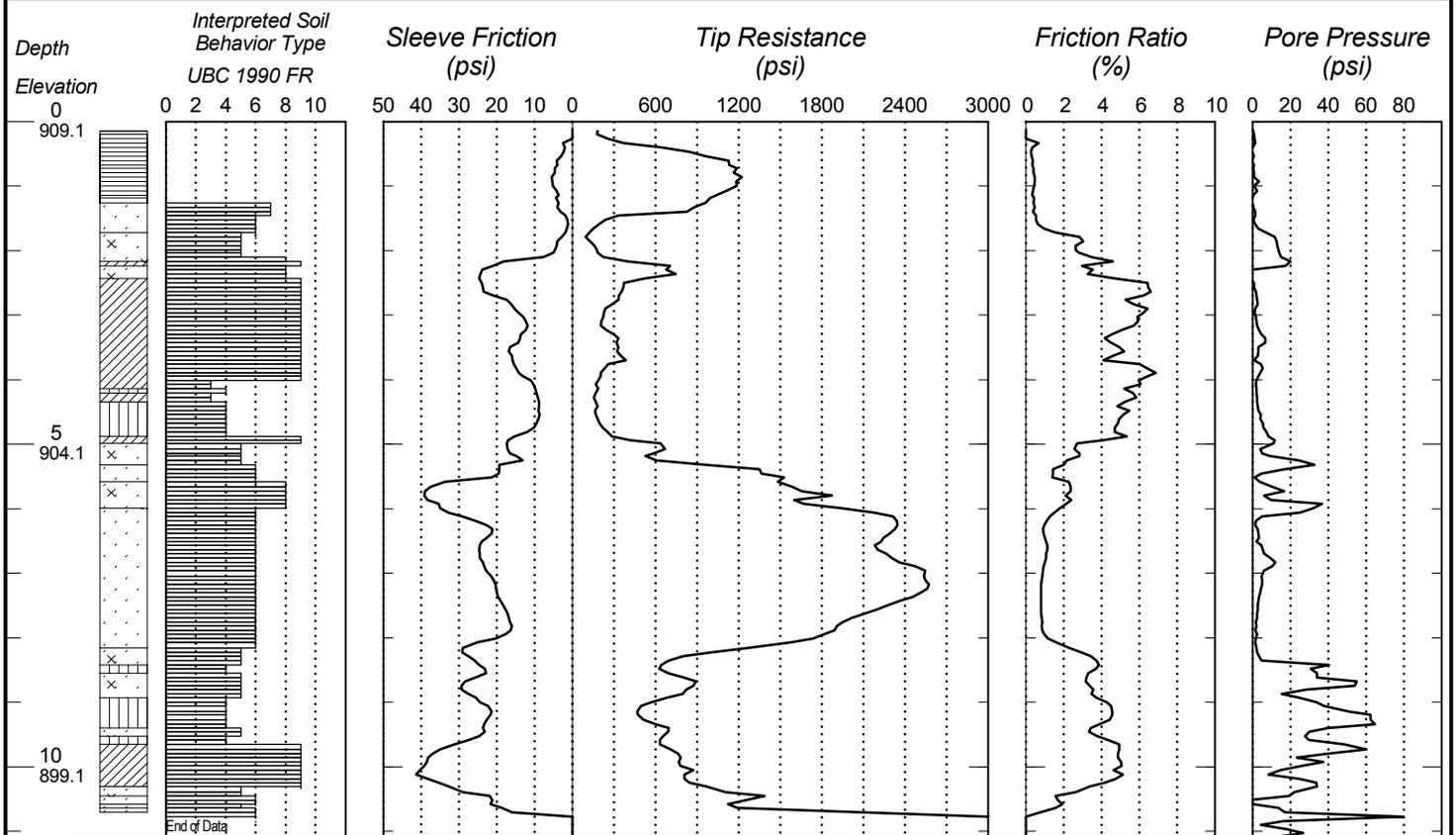


Bottom of Hole 14.44

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82824

| | | | | |
|---|---|--|-----------------------------|--|
| State Project 8825-652 | Bridge No. or Job Desc. OH SIGN MN100-142 | Trunk Highway/Location Various Metro | Sounding No. C08a | Ground Elevation 909.1 (DTM) |
| Location Ramsey County Coordinate System X=508644 Y=142248 | | CPT Machine 203094 CPT Truck | | SHEET 1 of 1 |
| Latitude (North)=44°54'25.12" Longitude (West)=93°20'59.91" | | CPT Operator O'Donnell | | Date Completed |
| | | Hole Type CPT-STD | | 11/29/17 |

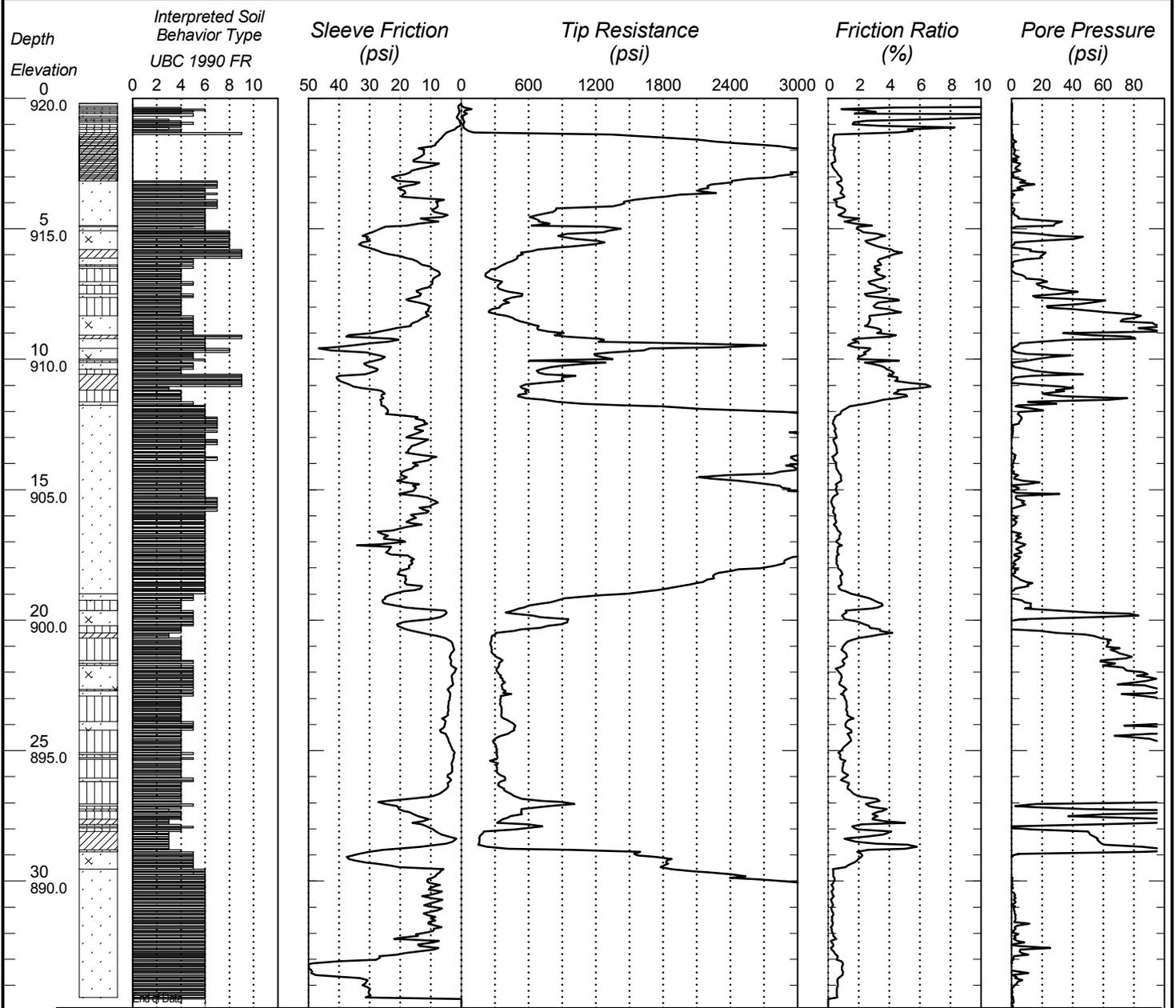


Bottom of Hole 11.09

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 82818

| | | | | |
|---|--|--|----------------------------|--|
| State Project 8825-652 | Bridge No. or Job Desc. OH SIGN MN 100-143 | Trunk Highway/Location Various Metro | Sounding No. C09 | Ground Elevation 920.0 (DTM) |
| Location Ramsey County Coordinate System X=508661 Y=146637 | | CPT Machine 203094 CPT Truck | | SHEET 1 of 1 |
| Latitude (North)=44°55'08.45" Longitude (West)=93°20'59.65" | | CPT Operator O'Donnell | | Date Completed |
| | | Hole Type CPT-STD | | 12/7/17 |



Bottom of Hole 34.85



Minnesota Department of Transportation Geotechnical Section BORING LOG DESCRIPTIVE TERMINOLOGY

USER NOTES, ABBREVIATIONS AND DEFINITIONS – Additional information available in Geotechnical Manual

This boring was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this boring was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this boring.

Since subsurface conditions outside each borehole are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this boring will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water levels recorded on this log should be used with discretion since the use of drilling fluids in borings may seriously distort the true field conditions. Also, water levels in cohesive soils often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

WATER MEASUREMENT

AB After Bailing
AC After Completion
AF After Flushing
wC with Casing
wM With Mud
WSD While Sampling/Drilling
w /AUG With Hollow Stem Auger

DRILLING OPERATIONS

AUG Augered
CD Core Drilled
DBD Disturbed by Drilling
DBJ Disturbed by Jetting
PD Plug Drilled
ST Split Tube (SPT test)
TW Thinwall (3" Shelby Tube)
WS Wash Sample
AB After Bailing
NSR No Sample Retrieved
WH Weight of Hammer
WR Weight of Rod
Mud Drilling Fluids in Sample
CS Continuous Sample

MISCELLANEOUS

NA Not Applicable
w with
w/o with out
sat saturated

SOIL CORE TESTS

SPT N₆₀ ASTM D1586 Modified
Blows per foot with 140 lb. hammer and a standard energy of 210 ft-lbs. This energy represents 60% of the potential energy of the system and is the average energy provided by a Rope & Cathead system.
MC Moisture Content
COH Cohesion (equivalent to 1/2 Unconfined Compression Strength)
γ Sample Unit Weight
LL Liquid Limit
PI Plasticity Index
φ Angle of Internal Friction
REC Percent Core Recovered
RQD Rock Quality Description (Percent of total core interval consisting of unbroken pieces 4 inches or longer)
ACL Average Core Length (Average length of core that is greater than 4 inches long)
Core Breaks..... Number of natural core breaks per 2 foot interval.

DISCONTINUITY SPACING

| | | |
|------------|--------------|-----------|
| Fractures | Distance | Bedding |
| Very Close | < 2 inches | Very Thin |
| Close | 2-12 inches | Thin |
| Mod. Close | 12-36 inches | Medium |
| Wide | > 36 inches | Thick |

RELATIVE DENSITY

| | | |
|-------------------------------------|-------|------------|
| <u>Compactness – Granular Soils</u> | | <u>BPF</u> |
| very loose | ..... | 0-4 |
| loose | ..... | 5-10 |
| medium dense | ..... | 11-24 |
| dense | ..... | 25-50 |
| very dense | ..... | > 50 |

Consistency – Cohesive Soils

| | | |
|-------------------------------------|-------|------------|
| <u>Consistency – Cohesive Soils</u> | | <u>BPF</u> |
| very soft | ..... | 0-1 |
| soft | ..... | 2-4 |
| firm | ..... | 5-8 |
| stiff | ..... | 9-15 |
| very stiff | ..... | 16-30 |
| hard | ..... | 31-60 |
| very hard | ..... | > 60 |

COLOR

| | | | |
|------|--------------------------|-----|--------------|
| blk | Black | wht | White |
| brn | Brown | yel | Yellow |
| orng | Orange | lt | Light |
| grn | Green | dk | dark |
| IOS | Iron Oxide Stained | gr | Grey |

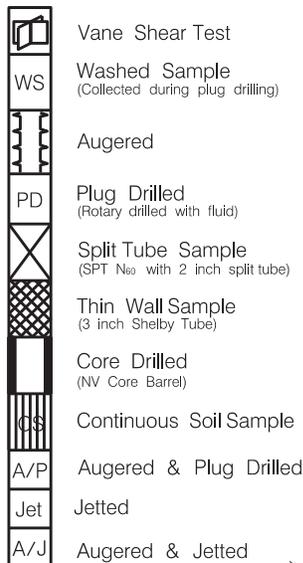
GRAIN SIZE /PLASTICITY

| | | | |
|----|---------------|------|----------------------|
| VF | ... Very Fine | pl | Plastic |
| F | ... Fine | slpl | ... Slightly Plastic |
| Cr | ... Coarse | | |

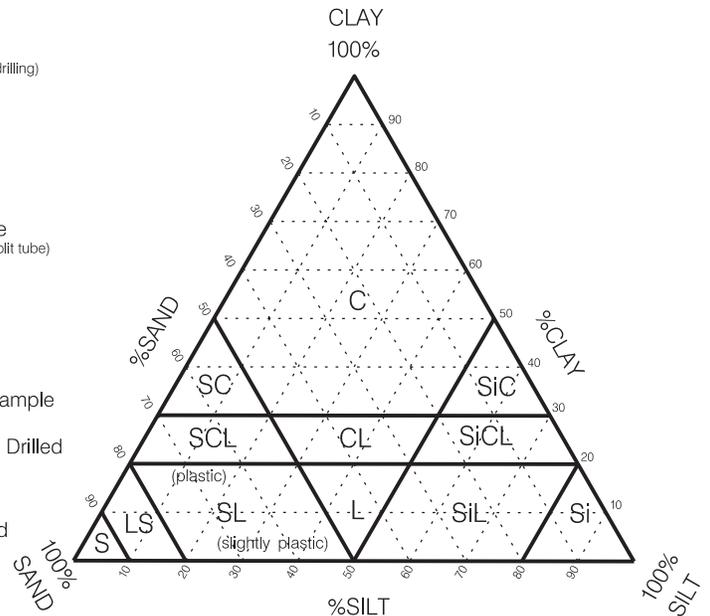
SOIL /ROCK TERMS

| | | | |
|------|---|------|-----------------|
| C | ... Clay | Lmst | ... Limestone |
| L | ... Loam | Sst | ... Sandstone |
| S | ... Sand | Dolo | ... Dolostone |
| Si | ... Silt | wx | weathered |
| G | ... Gravel (No. 10 Sieve to 3 in.) | | |
| Bldr | ... Boulder (over 3 inches dia.) | | |
| T | ... till (unsorted, nonstratified glacial deposits) | | |

DRILLING SYMBOLS



Mn/DOT Triangular Textural Classification System





Minnesota Department of Transportation Geotechnical Section



Cone Penetration Test Index Sheet 1.0 (CPT 1.0)

USER NOTES, ABBREVIATIONS AND DEFINITIONS

This Index sheet accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional boring logs.

This Cone Penetration Test (CPT) Sounding follows ASTM D 5778 and was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this sounding was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this sounding.

Since subsurface conditions outside each CPT Sounding are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this sounding will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water pressure measurements and subsequent interpreted water levels shown on this log should be used with discretion since they represent dynamic conditions. Dynamic Pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, water pressures often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

CPT Terminology

CPTCone Penetration Test
 CPTU.....Cone Penetration Test with Pore Pressure measurements
 SCPTUCone Penetration Test with Pore Pressure and Seismic measurements
 Piezocone...Common name for CPTU test

(Note: This test is not related to the Dynamic Cone Penetrometer DCP)

q_T TIP RESISTANCE

The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 cm² end area.

f_s SLEEVE FRICTION RESISTANCE

The resistance along the sleeve of the penetrometer.

FR Friction Ratio

Ratio of sleeve friction over corrected tip resistance.

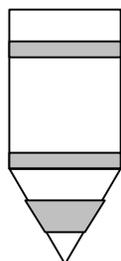
$$FR = f_s/q_t$$

V_s Shear Wave Velocity

A measure of the speed at which a seismic wave travels through soil/rock.

PORE WATER MEASUREMENTS

Pore water measurements reported on CPT Log are representative of water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to be dynamic water pressures due to the local disturbance caused by the cone tip. Dynamic water pressure decay and Static water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



U2

SBT SOIL BEHAVIOR TYPE

Soil Classification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these classification charts are meant to provide a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

The numbers corresponding to different regions on the charts represent the following soil behavior types:

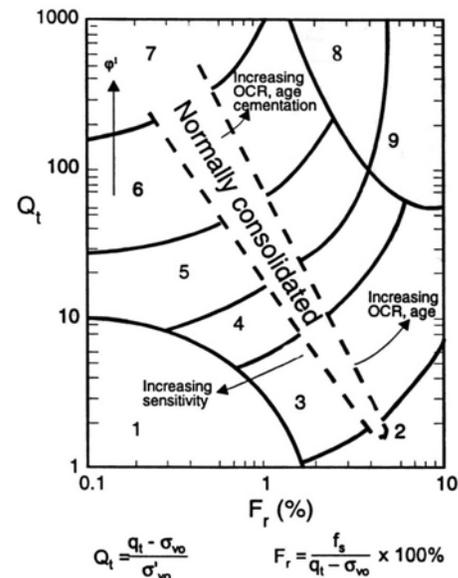
1. Sensitive, Fine Grained
2. Organic Soils - Peats
3. Clays - Clay to Silty Clay
4. Silt Mixtures - Clayey Silt to Silty Clay
5. Sand Mixtures - Silty Sand to Sandy Silt
6. Sands - Clean Sand to Silty Sand
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff, Fine Grained

Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts are used to provide a Soil Behavior Type for the CPT Data.

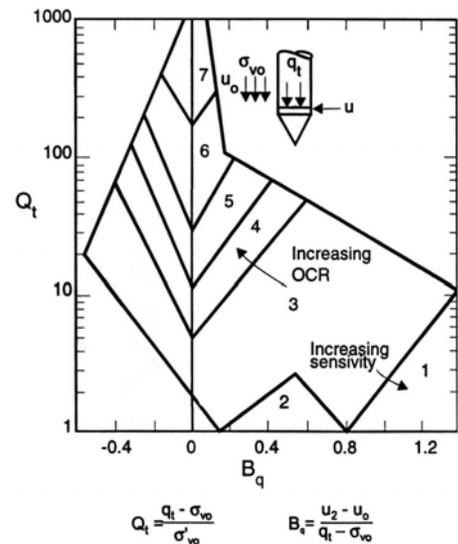
Robertson CPT 1990

Soil Behavior type based on friction ratio



Robertson CPTU 1990

Soil Behavior type based on pore pressure



where ...

- q_T..... normalized cone resistance
- B_q..... pore pressure ratio
- F_r..... Normalized friction ratio
- σ_{vo}..... overburden pressure
- σ' _{vo}..... effective over burden pressure
- u₂..... measured pore pressure
- u₀..... equilibrium pore pressure